HISTORY
OF THE
PROPAG.
& IMPROV.
OF
VEGETABLES

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SHARROCK, R.

2nd work part of
Fulton (Boyle) 107?

EDMUND WORRALL,
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THE 84907(2)

PRODROMUS
TO A
DISSERTATION
Concerning
SOLIDS Naturally Contained within SOLIDS.

Laying a Foundation for the Rendering a Rational Accompt both of the *Frame* and the ſeveral *Changes* of the Maſſe of the EARTH, as alſo of the various *Productions* in the ſame.

By *NICOLAUS STENO.*

Engliſh'd by *H. O.*

LONDON,
Printed by *J. Winter*, and are to be Sold
by *Moſes Pitt* at the *White-Hart* in
Little Brittain, 1671.

THE INTERPRETER TO THE *READER.*

READER,

T*His Ingenious Piece, lately publiſh't in* Italy, *(where 'twas Printed in* Latin,) *and thence come to the hands of the* Interpreter, *was thought fit to be Engliſh'd, chiefly upon this occaſion, That the Stationer, that hath Printed it, did, upon Information given Him of the Valuable Contents thereof, earneſtly ſollicite, that it might forth-with be put into* this *Language; he not only conceiving, that there* *being* now *very litle or no commerce between the* Engliſh *Book-ſellers, and thoſe of* Italy, *the conveyance of this Book, (as it doth of others* there *Printed) into* England *would prove very tardy; but alſo conſidering, that though within a reaſonable time ſome Copies of it ſhould come over, yet there would not be enough of them, to ſerve all ſorts of curious Engliſh-Men, nor even that number of Engliſh Readers verſed in the Latin Tongue, which this Conſiderable Diſcourſe is like to meet with, foraſmuch as it giveth very fair hopes, That by a due weighing of the particulars, therein laid down, the ſagacious Inquirers into Nature may be much aſſiſted to penetrate into the true knowledge of one of the* Great Maſſes *of the World, the* EARTH, *and therein to find out not only the* Conſtitution *of the Whole, but alſo the ſeveral* Changes, *and the various* Productions *made in the Parts thereof; as the Excellent* Robert Boyle *hath of late Years, with great Acuteneſs as well as unwearied Induſtry, led us on a great way in the knowledge of another of the great Maſſes, the* AIR; *though the ſame alſo hath not been unmindful of conſidering this very ſubject, here treated of; foraſmuch as*

He, before he would ſee or hear any thing of this Prodromus, *did upon occaſion candidly declare to the Author of this Verſion, (who* bona fide *here publickly atteſts it,)*

Firſt, *That he doth,upon ſeveral inducements, ſuppoſe, the generality of* Tranſparent *Gems or Precious Stones to have been once* Liquid *ſubſtances, and many of them, whilſt they were either fluid,or at leaſt ſoft, to have been imbraced with* Mineral Tinctures, *that con-coagulated with them; whence he conceiveth,that divers of the real qualities and vertues of Gems (for he doubts, moſt aſcribed to them are fabulous,) may be probably derived. And as for* Opacous *Gems and other Medical Stones, as* Bloud-Stones, Jaſpers, Magnets, Emery, *&c. He eſteems them to have, for the moſt part, been Earth (perhaps in ſome Caſes very much diluted and ſoft,) impregnated with the more copious proportion of fine Metallin or other Mineral Juyces or Particles; all which were afterwards reduced into the forme of Stone by the ſupervenience (or the exalted action) of ſome already in-exiſtent petreſcent liquor or petrifick Spirit, which he ſuppoſeth may ſome-*

times aſcend in the forme of Steams; from whence may be probably deduced not only divers of the Medical Vertues of ſuch Stones, but ſome of their other Qualities, as Colour, Weight, *&c. and alſo explained, How it may happen what He hath (and, he doubts not, others may have alſo) obſerved of Stones of another kind, or* Marcaſites, *or even Vegetable and perhaps Animal ſubſtances, that have been found incloſed in ſolid Stones: For, theſe Subſtances may eaſily be conceived to have been lodged in the Earth, whilſt it was but Mineral Earth or Mud; and afterwards to have been, as 'twere, caſed up by the ſupervenient Petrifick Agents that pervaded it.* *

* Of theſe *Pretious Stones* this Noble Philoſopher was pleaſed to leave with the Publiſher a *Manuſcript* of his compoſure, now ready to be Printed, which he aſſur'd him it had been ſeveral Years ago.

Nor are theſe Petreſcent *liquors the only ones, to which he ſuppoſeth that many Foſſils may owe their Origin, ſince he thinks, there may be, (if one may ſo ſpeak) both* Metalleſcent *and* Mineraleſcent *Juyces in the bowels of the Earth, and that ſometimes they*

they may there exiſt and operate under the forme of Spirits or Steams. *

* About which he alſo was willing not only to ſhew to the Publiſher ſeveral Obſervations and Collections of his in the forme of *Diſcourſes*, but alſo to put them into his hands to peruſe the ſame.

Beſides this, we cannot but take notice here of what was intimated a good while ago in *Numb.*32.of the *Phil.Tranſactions*, p.628. *viz.*That Mr.*Robert Hook* had at that time ready ſome Diſcourſes upon this very Argument; which,by reaſon of the many avocations he hath met with in the rebuilding of the City of *London*, and his attendance on the *R. Society*, he hath not yet been able quite to finiſh for the Preſs.

Now this being ſo, that ſeveral judicious Perſons do employ themſelves in the inquiry after the Obſervables in the greater Parts of the World, there is no queſtion but many remarkable things will be detected therein; and, (to ſpeak more generally on this occaſion,) ſince 'tis apparent, that the Ingenious and Diligent almoſt every where are entring more and more into Philoſophical Leagues,

for

for the diſcovery of the Works of God and the Operations of Nature, we cannot but entertain pregnant hopes, that notwithſtanding all the oppoſitions of Lazy and Envious Men, a good harveſt of conſiderable and uſeful knowledge will be reaped in time, and thence good ſtore of fruitful ſeed be miniſtred for large ſucceſſive crops of the ſame kind, for the magnifying of our great Creatour, and the enobling and benefiting of Man-kind.

THE

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MOST SERENE
Great DVKE.

IT often befalls Travellers in unknown Countries, that haſtening thorow a Mountanous Tract unto a Town ſtanding on the top of an Hill, they think it hard by, as ſoon as they come in ſight of it; although the manifold windings and turnings of the ways leading thereto, retard their hopes even to a trouble. For they have only a view of the neereſt tops, but they cannot gueſs what is hidden by the interpoſition of theſe high places; whether they be lower Hills, or deep Vallies, or plain Fields, becauſe with their flattering hopes they meaſure the diſtances of places by the eagerneſs of their deſires. 'Tis no otherwiſe with thoſe, that travel to the true knowledge of things by *Experiments:* For no ſooner have they the leaſt ſtricture of a truth unknown, but they imagine, the whole ſhall immediately open it ſelf to them; nor can they make a true eſtimate of the time requiſite to ſolve that continued *ſeries* of difficulties, which by little and little, riſing out of hidden depths, and ſtil caſting new impediments in the way, ſlacken the pace of thoſe that made ſo much haſte to attain the end of their courſe. The *beginning* of an Inquiry and Labour ſhews only ſome common and vulgarly known difficulties; but the particulars, wrapp'd up in them, the falſities to be removed, the truths to be eſtabliſh't, the obſcurities to be cleared, are ſeldom detected by any, until the thred of the Inveſtigation have led him unto them. Nor was it amiſs, that *Democritus* made uſe of the ſimilitude of a Pit, where a Man can hardly make a right eſtimate of the labour & time of drawing thence, but by having actually drawn up the things in it; for as much as the number and plenty of the latent Veins leave it very uncertain, what ſtore there is of the ſubterraneous matter.

You will not wonder therefore, *Moſt Serene Prince*, if for above a whole Years time, I have almoſt every Day ſaid, that that Diſquiſition, which was occaſioned by the Conſiderations upon the *Teeth* of a *Canis Carcharius*, * was nearly finiſh'd. For having once or twice ſeen thoſe Grounds, out of which are digg'd up *Shells*, and ſuch like other things caſt out by the Sea, and found, that thoſe Earths were the Sediments of a turbid Sea, and that every where we might eſtimate the number of times, how often the Sea had been troubled here and there, I haſtily not only imagined by my ſelf, but confidently affirmed to others, that the whole buſineſs would be an Inquiry and Work but of a very ſmall time. But when thereupon I am more attentively ſearching into particular Places and Bodies, there ariſe continually ſo many doubts cloſe following one another, that I often finde my ſelf brought back again as 'twere to the beginning of my Courſe, when I thought I was very neer the end thereof. I may reſemble thoſe doubts to the *Lernean Hydra's* Heads, becauſe I had no ſooner diſpatched one, but innumerable others grew up in their place: At leaſt I found my ſelf wandering in a Labyrinth, where, the neerer you are to the out-let, the more windings you finde your ſelf engaged in.

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* A *Shark fiſh*; concerning which this Author publiſhed a Diſcourſe in his *Deſcription of Muſcles*; of which an Account was given No. 32. of the *Phil. Tranſact.* p. 627.

But I ſhall not ſtay to excuſe this tardineſs of mine, conſidering it is ſo well known to your *Highneſs*, how difficult experimental Diſquiſitions are. But that I, after I have overcome a great part of the newly intimated labour, when I ſhould attempt ſome thing in *Anatomy*, do now deſire leave to return into my Country, this indeed would need an Apology, if I did not know, that your

Highneſs will not be diſpleaſed at that Obedience in the Subjects to another Prince, which, on the like occaſion, you would applaud in your own. Which hope conceiv'd by me of your Goodneſs, is raiſed higher by that ſingular favour, by which, when you vouchſafed to appoint me a liberal Penſion for the advancement of my ſtudies, you were pleaſed to leave me a liberty of returning into my Country, when occaſion ſhould require it. Since therefore I dare not make ſo long a ſtay, as is neceſſary to finiſh my Labors begun, I ſhall for the performing of my promiſe, do what is commonly practiſed by thoſe that are in great debts; who, that they may not be bank-rupt, when they have not what is ſufficient to pay all, do pay what they have: So *I*, ſince *I* am not able to diſpatch all what was to be offer'd to *Your Highneſs*, think my ſelf obliged, leaſt *I* ſhould appear to have amuſed you with meer words, to preſent you with the *chief* things of my performance in this Argument.

I would willingly have differr'd all till being returned home, *I* might have perfected every part of it, but that *I* muſt there expect the like fortune, which *I* have met with every vvhere, vvhich is, that *new* Labors have alvvays proved an impediment to the diſpatch of *others* formerly begun. My Deſign of deſcribing all the *Glanduls* of the Body, was directed by my ſearch into the wonderful Fabrick of the *Heart*. My endeavours concerning the *Heart* were interrupted by the Death of ſome of my neareſt Relations. VVhen I was upon giving a particular & minute account of the *Muſcles*, I was taken off by a *Dog* of a prodigious bigneſs, which your Seas preſented us with; And whilſt I am altogether addicted to the preſent Experiments, I am called away by Him, whom the Lavv of Nature, and the great Favours conferr'd on me and mine, command and preſs me to obey. VVhy all theſe things do ſo happen, *I* will not anxiouſly enquire; *I* ſhould perhaps attribute to my ſelf, what depends from a Superiour Cauſe. If to ſuch diſcoveries, as are not mine, *I* ſhould by long Meditations have added ſomething as 'twere of mine, certainly if *I* had very long inſiſted in improving one *Invention, I* ſhould have barred my ſelf from finding out others. Not knowing therefore, what other Experiments and Studies may abide me elſe-where, *I* thought *I* might do well, here to deliver thoſe things touching *Solids naturally included within Solids*, which might be a pledge of my grateful diſpoſition for benefits and favours received, and which alſo might afford occaſion to others, that enjoy leiſure, to improve the Study of Natural Philoſophy, and of Geography, with more advantage.

Concerning then the *Production of Solids naturally incloſed within Solids*; *I* ſhall *Firſt*, ſhortly delineate the Method of my Diſſertation; and *next* ſuccinctly diſcourſe of the more uncommon things, which occur upon that Subject.

The Diſſertation it ſelf *I* had divided into *Four* Parts; The firſt of which being a kind of *Introduction*, ſhevveth, that the *Queſtion* about *Marine* Bodies, found at a great diſtance from the Sea, is ancient, delightful, and of uſe; but that the true Solution of it, which in former times was leſs doubtful, hath in the later times been made much more uncertain. And

having

having thereupon declared the Reaſons, why later Authors have receded from the Opinion of the Antients, and why hitherto the Controverſie hath not been fully decided, though many things be found very well written upon by divers, yet at length returning to You, *Moſt Serene Prince*, after many other things, partly found a new, partly freed from old doubts by your Patronage and encouragement, *I* ſhow that we owe alſo to You the hope we have, that this matter alſo will ſhortly be brought to an iſſue.

In the *Second* Part is reſolved the *General Probleme*, whence depends the Explication of every difficulty in this Point, which is, *A Body of a certain Figure, and naturally produced, being given, to finde in the Body it ſelf Arguments, diſcovering the Place and Manner of its Production.* Here, before *I* proceed to make out this Probleme, *I* endeavour to explain all the words thereof in that ſenſe, which no Sect of Philoſophers ſhall find any thing in to except againſt it.

The *Third* Part I have deſigned for the Examination of the *particular Solids* included in a Solid, according to the Laws laid down in the Reſolution of the *Probleme.*

The *Fourth* Part ſheweth the ſeveral ſtates of *Hetruria* or *Toſcany*, untouched by Hiſtorians and Writers of Natural Hiſtory; and propoſeth a way of the *General Deluge*, not repugnant to the Laws of Natural Motions.

And theſe particulars I had begun to deliver in the *Italian* Language, both becauſe I underſtood, it would be acceptable to Your *Highneſs*, and alſo that I might manifeſt to that Illuſtrious Academy, which hath received me into their Body, that I, who am very unworthy of that honour, do exceedingly covet to expreſs my endeavour to attain ſome knowledge of the *Toſcan* Language. Nor am I diſpleaſed, that a neceſſity is impoſed upon me to put off that writing; for, as the approaching Voyage promiſeth me a fuller knowledge of thoſe things, which may ſerve to clear up this Argument; ſo a greater ſpace of time giveth me hopes, I may make a more happy progreſs in that Language.

As to the *Things* themſelves, diſcourſed of, according to the lately mentioned Method, it would be tedious, to tranſcribe all the Obſervations together with the Concluſions thence deduced. Wherefore I ſhall here relate only, ſometimes Concluſions, ſometimes Obſervations, according as it ſhall ſeem moſt proper to indicate things with brevity and plainneſs.

Now therefore that in the Reſolution of Queſtions about Natural things moſt Doubts remain not only undecided, but are for the greateſt part of them, according to the number of Writers, increaſed, this ſeems to me chiefly to depend from *Two* Cauſes.

The *Firſt* is, that few Men undertake to diſcuſſe *all* thoſe difficulties, without the reſolution of which the clearing of the Queſtion remains imperfect. Of this the Argument now under conſideration affords an eminent Example. The Ancients were exerciſed with one only difficulty, which was, How *Marine* Bodies came to be left in Places remote from the Sea; nor was it ever made a queſtion amongſt you, Whether ſuch Bodies came from any Place elſe than the Sea.

But in latter Ages the difficulty, vvhich was amongſt the Ancients, hath been more ſparingly urged, and inſtead thereof, they have almoſt all buſied themſelves about the Origin of the ſaid Bodies. Thoſe that adſcribed them to the Sea, labour'd to ſhew, that ſuch kind of Bodies could not be produced otherwiſe. The *others* that attributed them to the Earth, denyed, that the Sea could ever cover theſe *Lands*, where they were found; and they employed their wit in extolling the Powers of Nature, as able to produce any thing whatſoever. And though the *Third* Opinion, which will have ſome of the ſaid Bodies to be due to the Earth, others to the Sea, want not Patrons and Abettors; yet there is almoſt every where a deep ſilence of the Doubt of the Ancients; only that ſome make mention of Inundations, and I know not what immemorial courſe of Ages; though they do that but overly, and as 'twere by the by. That therefore I might comply with the Laws of an *Analyſis*, as far as I could, I have ſo often woven over and over the Webb of this Inquiry, and ſearched through every part thereof, till I found no difficulty left in the reading of Authors, nor in the Objections of Friends, nor in the Inſpection of Places, which either I have not reſolved, or at leaſt determin'd, as far as by the things, hitherto diſcover'd by me, could be reſolved. The *Firſt* Queſtion was, Whether the *Gloſſopetræ* of *Maltha* had formerly been the Teeth of Sea-Doggs: Which quickly appear'd to be the ſame Queſtion with that *General* one, namely, Whether Bodies like to Marine Bodies, found at a great diſtance from the Sea, had been anciently produced in the Sea? But now, ſince there are found in the Earth other Bodies, that are like thoſe, which grow in ſweet Waters, in the Ayr, and other Fluids; if we give to the Earth a power to produce theſe Bodies, we cannot take from her the faculty of producing others: And therefore the Queſtion was to be extended to all thoſe Bodies, which being digged out of the Earth, are found *like* to thoſe, which elſewhere we ſee grow in a Fluid. But we alſo finde in Stones, many other Bodies having certain Figures, which if one ſhall ſay they are there produced by the power of the place, he will be neceſſitated to acknowledge all others to be produced by the ſame power. So that I have found the matter reduced to this, that we were to examine *Every Solid naturally included in a Solid*, *viz.* Whether it was produced in the ſame place where it is found, that is, we were to conſider the nature *both* of the place where it is found, *and* of the place where it is produced. But no Man will eaſily determine the *Place* of Production, who knows not the *Manner* of the Production; and all diſcourſing of the manner of Production will be to no purpoſe, if a certain knowledge be not had of the *Nature* of *Matter*. Whence it appears, how many Queſtions are to be reſolved only to ſatisfie one.

The *other* Cauſe, feeding doubts, ſeems to be this; That in the Examination of Natural things, thoſe that cannot be certainly determin'd, are not diſtinguiſht from ſuch, as may be ſo; Whence ariſe two principal ſorts of Philoſophers: *Some* are ſcrupulous to aſſent even to Demonſtrations themſelves, apprehending leaſt in them alſo there ſhould lurk the like errour, as they have frequently diſcover'd in other Aſſertions: *Others*, on the contrary, will by no means be confined to hold only thoſe things for true, which no Man of ſound reaſon and good ſenſe will disbelieve; but they eſteem all thoſe things true, which to them appear to be pretty and ingenious. Yea, the Patrons of Experience themſelves have ſeldom obſerved that moderation; but have either rejected even the moſt certain Principles of Nature, or have held the Principles invented by themſelves for demonſtrated. Therefore to avoid this Rock alſo, I have deemed fit to urge that in *Phyſicks*, what *Seneca* hath often inculcated in *Morals*; where he affirms thoſe Precepts of *Manners* to be the beſt, which are common to all, publick, and agreed unto by all of all the Families of Philoſophers, *Peripateticks*, *Academicks*, *Stoicks*, *Cynicks*. And indeed, me thinks, that thoſe Principles of Nature cannot but be beſt, which are common, and publick, and acknowledged by all Schooles, as well by thoſe, that are Lovers of Novelty, as thoſe that are addicted to Antiquity.

Wherefore I determine not, Whether

the Particles of a Natural Body may, as to their Figure, be changed or not? Whether there are little Vacuities or no? whether there be in thoſe Particles, beſides *Extenſion*, and *Hardneſs*, ſome others unknown to us? For theſe are not *Publick Voyces*; and 'tis a weak Argument, to deny that there is ſomething elſe in a thing, becauſe I do not obſerve it there.

But I do without heſitation deliver; 1. That a Body Natural is an Aggregate of inſenſible Particles, pervious to Operations flowing from the Magnet, the Fire, and ſometimes alſo from Light; in what manner ſoever the open paſſages be found either *between* the Particles, or *in* the Particles themſelves.

2. That a *Solid* herein differs from a *Fluid*, that in a *Fluid* the inſenſible Particles are in perpetual motion, and part from one another; but in a *Solid*, although the inſenſible Particles be moved ſometimes, yet they ſcarce ever part from one another, as long as that Solid remains a Solid and entire.

3. That, whil'ſt a Solid Body is produced, the Particles thereof are mov'd from one place to another.

4. That hitherto in the nature of Matter there is nothing known to us, whereby the Principle of the Motion, and the Perception of Motion may be explicated; but that the determination of Natural Motions may be changed from *three* Cauſes.

Firſt, From the Motion of the Fluid permeating all Bodies; and what things are this way produced, are ſaid by Us to be produced *Naturally*.

Secondly, From the Motion of Animals; and the things that are done this way are many of them called *Artificial*.

Thirdly, From the firſt and unknown Cauſe of Motion; and in thoſe that are done this way, the *Pagans* themſelves believed there was ſomething of Divine. Certainly to deny to this Cauſe a power of producing effects contrary to the uſual courſe of Nature, is the ſame, as if we ſhould deny to Man the power of altering the Courſe of Rivers; the power of kindling Fire in places, where without it it would never be kindled; of extinguiſhing Light, which elſe would not vaniſh but by the ceaſing of matter; of inoculating a twig of one Plant into the branch of another Plant; of bringing upon a Table the Fruits of Summer in the midſt of Winter; of producing Lee in the heats of Summer, and a thouſand ſuch other things, repugnant to the ordinary Laws of Nature. For, if we our ſelves, who do ignore both our own Fabrick,and that of other Bodies, do daily change the Determination of Natural Motions; why ſhould not He be able to change the determination of the ſame, who doth not only know,but hath produced *our* frame, and *that* of all other things? Now to be ready to admire in Artificial things the Wit of Man acting freely, and yet to deny to things produced by Nature a Free Mover, *that* indeed would ſeem to me a great ſimplicity in a pretended ſubtilty, whereas Man, when he hath made the moſt Artificial things, does not ſee but very darkly what he hath done, nor what Inſtruments he hath uſed,nor what is that cauſe that moveth the Inſtruments.

All theſe particulars I do at large diſcourſe of, as demonſtrated both by Experiments and Reaſon;to ſhew,that there is none of the Philoſophers,but he either ſaith the ſame, though he do not always uſe the ſame words, or, if he ſpeak differently, yet admits the ſame, whence theſe things neceſſarily follow. For, what I have affirm'd of *Matter*, hath place every where, whether you take Atoms for your Matter, or Particles a thouſand ways variable, or the Four Elements, or the Chymical Principles, never ſo much varied according to the variety of Chymiſts. So alſo what I have propoſed of the *Determination* of Motion, agreeth with every Mover, whether you make it to be the Form, or the Qualities flowing from the Form, or the Idea, or the common Subtile matter, or the proper Subtile matter, or the particular Soul, or the Soul of the World, or the Immediate concourſe of God.

Conformably to the ſame, I give an account of the various ways of ſpeaking, commonly received, whereby we diverſly explain the different production of different, and ſometimes of the ſame Bodies. For, whatever contributeth any thing to the production of a Body, *that* acts either as a *Place*, or as *Matter*, or as a *Mover*; hence when like produceth like, it giveth it both Place and Matter, and the

Motion of production; as a Plant, included in the ſeed of a Plant, had from another Plant *both* the Matter *wherein* 'tis produced, *and* the Matter *out of which* 'tis produced, *and* the Motion of the Particles by which 'tis formed: which ſame thing is certain of Animals included in the Egg of the like Animals.

Whilſt the *particular Forme*, or the *Soul*, produceth a thing, the motion of the Particles in the production of that Body is determined by ſome particular Mover, whether it be the Mover of another like Body, or ſome other thing like to this Mover.

The things ſaid to be produced by the *Sun*, have the Motion of their Particles from the Sun-beams, as thoſe, that are adſcribed to the Influences of the Stars, may have from the Stars the motion of their Particles. For it being certain, that our Eyes are moved by the light of the Stars, it will alſo be beyond all controverſie, that the reſt of matter is likewiſe capable to be moved by the ſame.

What the *Earth* produceth, hath nothing elſe from the Earth, than the Place in which it is produced, and the matter miniſtred to it through the Pores of the Place.

Things produced by Nature have the motion of their Particles from the motion of ſome penetrating Fluid, whether that Fluid come from the Sun, or from Fire contained in ſome terreſtrial matter, or from any other cauſe unknown to Us, as an Inſtrument to the Soul, *&c.*

He therefore that aſcribeth the production of a thing to *Nature*, intimateth and nameth the *Mover General* in the production of all things. He that taketh in the *Sun*, doth ſomewhat more define the ſame Mover. He that nameth the *Soul*, or a *Particular Forme*, alledgeth yet a more determinate cauſe than the other. Mean time, who ever ſhall duly weigh the Anſwers of all theſe, will find nothing in them but what's occult, for as much as *Nature*, the *Sun-beams*, the *Soul*, and a *Particular Form*, are nothing elſe but *Names*. But ſince that in the production of Bodies, there are, beſides the *Mover*, to be alſo conſider'd the *Matter* and *Place*, it hence appears, that not only the Anſwer is more unknown than the thing ſought, but alſo very imperfect, when 'tis ſaid, that *Cockle-ſhells* found in the Earth are produced by *Nature*, becauſe thoſe likewiſe that grow in the Sea, are the workmanſhip of Nature alſo. 'Tis true that Nature produceth *all*, ſeeing that in the production of all things, penetrating Fluids have their place: But then it may alſo be juſtly ſaid, that Nature produceth *nothing* by her ſelf, becauſe ſhe expects determination from the Matter that is to be moved, and from the Place. As for Example, *Man*, who may do any thing, if all neceſſaries be at hand, but they being wanting, he ſhall do nothing.

He that ſhall adſcribe the production of a thing to the *Earth*, nameth, 'tis true, a *Place*; but ſince to all terreſtrial things the Earth affords *place* (at leaſt in part) and yet the place alone is not ſufficient to produce a Body, it may be ſaid of the *Earth*, what was lately ſaid of Nature, *viz.* That all the things that are produced *in* the Earth are produced *by* the Earth; and again, that of all the things that are produced *in* the Earth, none is produced *by* it.

Theſe very things, which are but few,

thus declared, are ſufficient to reſolve all the doubts of the *Queſtion propoſed*, which I ſhall here comprehend in the three Propoſitions following.

I.

If a Solid Body be every where encompaſs'd by another Solid Body, that of the two was firſt hardned, which in the mutual contact doth expreſs on its ſuperfice the proprieties of the ſuperfice of the other.

Hence obſerve,

1. That in thoſe Solids, whether Earths, or Stones, which do round about environ and contain Chryſtals, Selenites's, Marcaſits, Plants, and their parts, Bones and Shells of Animals, and ſuch other Bodies having a ſmooth ſurface, thoſe very Bodies were then already hardned, when the Matter of the Earths and Stones containing them was yet fluid; and conſequently that thoſe Earths or Stones are ſo far from having produced the Bodies contain'd in them, that they were not there exiſtent, when thoſe Bodies were there produced.

2. If there be in part included a Chryſtal in a Chryſtal, a Selenites in a Selenites, a Marcaſite in a Marcaſite, that theſe

Bodies contain'd were then already hard, when a part of the Bodies containing was yet fluid.

3. In thoſe Earths and Stones, wherein are contained Chryſtallin and Lapideous ſhells, Veins of Marble, of Lapis Lazulus, of Silver, Quickſilver, Antimony, Cinnaber, Copper, and other ſuch Minerals, the Bodies containing were then already hard, when the matter of the Bodies contain'd was yet fluid; and conſequently Marcaſites were produced firſt; then the Stones wherein they are included; then the Veins of Minerals, which fill up the fiſſures of the Stones.

II.

If a Solid Body be every where like another Solid, not only as to ſurface, but alſo in the inner conſtitution and frame of its parts and particles, then it will alſo be like it as to the Manner and Place of its production, excepting thoſe conditions of place, which are often fonnd in a place and are no advantage or diſadvantage to the production of a Body.

Whence it follows,

1. That the *Beds* of the Earth, for the place and manner of their production,

agree with thoſe Beds, which turbid Waters let fall.

2. That Rock or Mountain-Chryſtals, for the manner and place of production, agree with Chryſtals of Niter; though it be not therefore neceſſary, that that Fluid be *aqueous*, in which they are produced.

3. That thoſe Bodies, which being digg'd out of the Earth, are altogether like the parts of Plants and Animals, were produced in the ſame manner and place, in which the very parts of Plants and Animals are produced. But to the end that the ambiguous ſence of the word *Place* may not beget new doubts, I ſhall obviate that difficulty.

I underſtand therefore by the word *Place*, that Matter, which by its ſuperfice immediately toucheth the ſuperfice of that Body, which is ſaid to be in that *Place:* which Matter admits of various differences; for,

Firſt, 'Tis either all ſolid, or all fluid, or partly the one and partly the other.

Secondly, 'Tis either all ſenſible by it ſelf, or in part ſo, and in part by its operations.

Thirdly, 'Tis either altogether contiguous to the Body contain'd, or in part continuous to the ſame.

Fourthly, 'Tis either always the ſame, or by little and little changed. Thus a place wherein a Plant is produc'd, is that matter of the like Plant, within which the little Plant is form'd. So the Place, wherein a Plant grows, is all that matter, which by its ſuperfice immediately toucheth the whole ſuperfice of the Plant, ſometimes made up of Earth and Air, ſometimes of Earth and Water, ſometimes of Earth, Water and Air, ſometimes of a Stone alone and of Air, as in ſub-terraneous places there are often ſeen Roots of ſmall Plants wholly ſticking to the ſurface of a Toph-ſtone, not cover'd at all by any Earth or Duſt. So the place, where from a fallen bloſſom grows an Orange, is partly the little *pedunculus* or ſtalk continuous to it, partly the contiguous Air. Likewiſe the Place, where an Animal firſt begins to grow, is partly the liquor of the *Amnion* contiguous to it, partly the continuous Umbilical Veſſels diffus'd through the *Chorion*.

III.

If a Body be produced according to the Laws of Nature, it is produced out of a Fluid.

In the production of a Solid Body there ſhould be conſider'd the firſt Lineaments as well as the increaſe of it. But, as I candidly acknowledge that the *firſt Delineation* of them is not only doubtful but quite unknown to me, ſo I eſteem without almoſt any ſcruple, that the following particulars are true concerning their *Increaſe.*

A Body increaſeth by an Appoſition of new Particles ſevered from an *External* Fluid: But this Appoſition is made either by an external Fluid *immediately*, or *mediately* by an internal Fluid, one or more.

Such parts as are from an External Fluid *immediately* joyned to a Solid, do in ſome, fall down to the bottom by their own weight; in others, being by the penetrating Fluid of a Solid determin'd towards a Solid, are either joyned round about to the Solid, as in Incruſtations, or only to certain places of the ſolid ſurface, as in thoſe Bodies, which repreſent

Threds, Branches, and Angular Bodies. Where (by the by) it may be noted, that the ſaid ways are ſometimes continued, until ſome ſpace be wholly filled up by them; whence come *Repletions*, which ſometimes are ſimple and plain, ſometimes compoſed of Cruſts, or of Sediments, or of Angular Bodies, or of divers, variouſly mixt among themſelves.

Thoſe Particles, which by an *intermediate* internal Fluid are joyned to a Solid, *either* aſſume the Figure of Fibres (in as much as *partly* they are conjoined according to the length of the extended ſmall fibre, the pores being open'd, *partly* as they are, in the interſtices of the ſmall fibres, by the permeating Fluid diſpoſed for the figure of a new ſmall fibre,) *or* make ſimple repletions: by which two kinds of parts, Plants and Animals are compoſed. Being leſs verſed in the *Anatomies* of *Plants*, I determine not, whether there be in them ſeveral inward Fluids; in *Animals* 'tis certain that there are, which I ſhall endeavour to reduce into order.

Beſides a Subtil fluid pervading all, we obſerve at leaſt *three* ſorts of Fluids in Animals, of which the firſt is *External*; the ſecond, *Internal* and *Common*; the third, *Internal*, and *Appropriate* to each part.

By the word of *External* Fluid in Animals I underſtand not only that, which encompaſſeth the viſible ſurface like an Atmoſphere, but that alſo, which toucheth all the other ſurfaces of the Body that by the greater holes are continued to the ſaid ſurface; ſuch as are, the ſurface of the *Aſpera arteria* or Wind-pipe, which the Air inſpired toucheth; the whole ſurface of the way of the Aliment, by which I mean the Mouth, the Weaſand, the Stomach, and the Entrals; the whole ſurface of the Bladder and the *Urethra*; the whole ſurface which hath communication with the Womb, at leaſt in the years of ripe age; the whole ſurface of all the excretory Veſſels, continued from the capillaries unto the orifices, which diſcharge their contents into the Ears, Eye-lids, Noſtrils, Eyes, the way of Aliments, the Bladder, the *Urethra*, the Womb, and the Skin; the particular enumeration and deſcription of which would ſhow, that many are indeed extrinſick, which are eſteem'd intrinſick,and even inmoſt;by the Vulgar; and conſequently,

1. That the Worms and Stones generated *within* our Body, are moſt of them produced in the *external* fluid.

2. That divers parts are neceſſary to Animals, becauſe they are there, not that the Animal could not *be* without them.

I call the Fluid,which toucheth theſe ſurfaces, *External*, becauſe it communicateth with the ambient fluid by channels without any intermediate capillary Veſſels, that is, without percolation or ſtraining: whereby it comes to paſs,that though the cavities, containing the ſaid fluids, be ſometimes ſhut, yet as often as they are open'd, they diſcharge all the parts of the retain'd Fluid without diſcrimination.

I call that Fluid *Internal*, which hath no communication with the *External* fluid, but by the intermediate ſtrainers of the Capillary Veſſels,and therefore naturally never transfuſeth all its parts into the outward Fluid without ſome difference.

The *Common* internal Fluid is that,

which is contained in Veins, Arteries, and Lymphatick Veſſels, at leaſt thoſe, which are betwixt the conglobate glenduls and the Veins intercepted. I call this fluid *Common*, becauſe it is diſtributed towards all the parts of the Body. Of that other Common Fluid, which is contain'd in the Nervous ſubſtance, ſince 'tis leſs known, I determine nothing.

An *Appropriate* internal Fluid is that, which is circumfuſed about the capillary Veſſels of the *common* Fluid, and is different according to the diverſity of places: for there is another in the ſanguineous *parenchyma's*, another in the exanguious ones; another, about the moving fibres; another, in the Egg-ſhell; another, in the ſubſtance of the Womb; another in other places. Nor is that Opinion agreeable to Reaſon or Experience, which holds, that the extremities of the Veins and Arteries terminate in every the ſmalleſt particle of the Body, for the diſtribution of warmth and food to them all; but there are every where cavities, into which the parts ſever'd from the blood are mixed with the Fluid of that place, and thence to be added to the ſolid parts; as again the Particles worn off from the ſolid parts fall back again into thoſe hollowneſſes, to be again reſtored to the blood, and thereby to be conveyed away to the external Fluid. The Fluid of theſe cavities is in divers things conſonant to the Doctrin of the great *Hippocrates* concerning *Flatus's:* Although I am not able to determine, why in divers places from the ſame blood are diſcharged different Fluids; yet I hope that there wants but little for the determination of it, in regard 'tis certain, that that depends not from the Blood, but from the Places themſelves; the conſideration of which may be included in theſe three particulars.

Firſt, By conſidering the Capillary veſſels of the *common* internal Fluid; which is alone heeded by thoſe, who aſcribe all to the percolation through divers Pores; of which number I once was my ſelf.

Secondly, By conſidering the *Appropriate* internal Fluid; about which alone thoſe are converſant, who attribute to every part a peculiar Ferment; whoſe Opinion may be true in part, though the word *Ferment* depend on a compariſon taken from ſo peculiar a thing.

Thirdly, By conſidering the Solid of every part; to which thoſe adhere chiefly, who by attributing to each part its forme, do intimate that they acknowledg there to be ſomething proper, which yet is unknown to us; and which according to that knowledge of matter, that we have hitherto obtained, can be nothing elſe but a Porous ſurface of that Solid, and a ſubtile Fluid permeating thoſe pores.

I ſhould too much wander from my ſubject, if I ſhould apply the things, I have diſcours'd of, to what daily happens in our Body, and cannot be rationally explicated otherwiſe. It may be ſufficient to have hinted here, that the Particles, which do many ways part from the external Fluid, are carried into the internal Fluid, by the means of Percolation; whence being likewiſe variouſly ſever'd, and by a new cribration tranſmitted into the Appropriate internal Fluid, they are added to the ſolid parts, either by way of Fibres, or Parenchyma's, according as they ſhall have been determin'd by the to us yet unknown propriety of every part, included in the conſideration of the three lately mention'd particulars.

If therefore you have a mind to reduce, by the related Method, the Solids naturally included in Solids, to certain Heads, you will finde, that,

1. *Some* of them are produced by Appoſition from an External Fluid, which may be referr'd either to *Sediments*, as the Beds of the Earth; or to *Incruſtations*, as the Agat, Onyx, Chalcedony, Eagle-ſtone, Bezoar, *&c.* or to *Threds*, as Amianthus, Alumen plumoſum, and various kinds of Threds, found by me in the fiſſures of Stones; or to *Ramifications*, as thoſe figures of Plants, which are ſeen in the crevices of ſtones, and are but ſuperficial; and certain branchings in an Agat ſeen by me, whoſe trunks inſiſted on the ſuperfice of the outer plate, but the branches ſpred themſelves through the ſubſtance of the inner plate; or to *Angular Bodies*, as Rock-Chryſtal, Angular Bodies of Iron and Copper, Cubes of Marcaſites, Diamonds, Amethyſts, *&c.* or to *Repletions*, as all ſorts of party-colour'd Marbles, Granats, Dendroitids, Stony and Chryſtallin Shells, Metallick Plants, and many ſuch like Bodies, filling

up the places of Bodies conſumed.

2. *Others* are produced by Appoſition from an *Internal* Fluid; which are referable *either* to *Simple Repletions*, as Fat, Brawnineſs uniting broken Bones; a Griſtly ſubſtance connecting cut Sinews; Affuſions chiefly conſtituting the ſubſtance of the Guts; Marrow both in Plants and Animals: *or* to *Fibrous parts*, as are the fibrous parts of Plants; and in Animals the nervous fibres, and the moving fibres; all which are ſolid Bodies, and for the moſt part naturally included in ſolids.

If therefore every Solid hath had its increaſe (at leaſt,) from a Fluid; if Bodies, that are altogether like one another, have been produced after a like manner, and if of two Solids, contiguous to one another, *that* was hardned firſt, which exhibits on its ſurface the proprieties of the other's ſurface; it will be eaſy, when a Solid is given, and the Place where 'tis, to pronounce ſomething certain of the manner and place of its production.

And thus much for a *General* Conſideration of a *Solid contain'd within a Solid.*

I proceed therefore to examine more *particularly* thoſe Solids digg'd out of the Earth, which have occaſioned many controverſies, eſpecially *Incruſtations*, *Sediments*, *Angular Bodies*, *Shells* of dead Sea-Animals, and the *Figures* of *Cockles* and *Plants*.

To *Incruſtations* do belong all ſorts of Stones made up of *Lamellæ* or *Plates*, the two ſurfaces of which are indeed parallel, but lye not in the ſame plain. The Place where Incruſtations are made; is the whole confine of the Fluid and Solid; whereby it comes to paſs, that the Figure of the Plates or Cruſts anſwers to the figure of the *place*, and that 'tis eaſily determinable, which of them was concreted firſt, which laſt: For, if the Place be *Concave*, then the outer cruſts were formed firſt; if *Convexe*, the inner: If the Place be Un-even by various great protuberancies, there, when the narrower ſpaces were fill'd up by Plates firſt made, new Plates were produced in the larger ſpaces. Whence 'tis eaſy to render an accompt of all the varieties of Figures, which are ſeen in the Cuts of ſuch Stones, whether they repreſent the round Veins

of

of a tranſverſly diſſected Tree; or imitate the winding flexures of Serpents, or run otherwiſe, inflected at randome. Nor is it to be wondred, that *Agats*, and other kinds of Incruſtations appear, on the outer ſurface, rough like common ſtones, conſidering that the exteriour ſurface of the outer Plate expreſſeth the roughneſs of the Place. But in Torrents ſuchkinds of Incruſtations are often found out of the place of their production, becauſe by the rupture of the Beds the matter of the place hath been thrown here and there.

Touching the *Manner*, how from a Fluid the particles of the Cruſts, that are to be conjoyned to the Solid, are ſever'd, theſe particulars, at leaſt, are certain.

1. That Levity or Gravity hath no place there.

2. That the ſaid particles are joyned to all ſorts of ſuperfices, becauſe that ſmooth, rough, even and crooked ſuperfices, and ſuch as are made up out of divers plains variouſly inclined, are found covered with cruſts.

3. That the Motion of the Fluid is no impediment to them.

Mean while, whether the ſubſtance which floweth from the Solid, be different from that which agitateth the particles of the Fluid; or whether we are to ſearch for ſomething elſe, I ſhall not determine.

The *Varieties* of Plates in the ſame Place may be deduced *either* from the diverſity of the particles that come away from the Fluid, according as one and the ſame fluid is by degrees more and more reſolved; *or* from divers Fluids conveyed thither at divers times; wherby it comes to paſs, that there is ſometimes reiterated the ſame rank of *Lamellæ* in the ſame place, and that there appear often manifeſt marks teſtifying an ingreſs of new matter.

But all the *Matter* of Plates ſeems to be the finer ſubſtance exhaling out of Stones; as may be made out by what is to follow hereafter.

The Strata or Beds of the Earth.

To the Sediments of Fluids do belong the *Strata* or *Beds* of the *Earth*.

1. Becauſe it appears not, that the Duſty matter of the Beds can have been otherwiſe reduced into that Figure, if it

had not, by being commix't with ſome Fluid, & falling thence by its own weight, been made plain by the motion of the ſame incumbent fluid.

2. Becauſe the greater Bodies contain'd in the ſame Beds do for the moſt part obſerve the Laws of Gravity, *both* as to the ſcite of each Body by it ſelf, *and* as to the ſcite of various Bodies amongſt themſelves.

3. Becauſe the Duſty matter of the Beds hath ſo accommodated it ſelf to the Bodies contain'd, that it hath *both* filled up every ſmall cavity of the contain'd Body, *and* expreſſed the ſmoothneſs and brightneſs of the ſame Body in that part of its ſurface where it toucheth it, though the roughneſs of the Duſt anſwers not at all to ſuch a ſmoothneſs and gloſs.

But the *Sediments* are made thus, *viz.* that the Matter contain'd in a Fluid falls by its own weight down to the bottom, *whether* thoſe things contain'd be conveyed thither from elſewhere, *or* be by little and little ſecreted from the very particles of the Fluid, and that *either* in the upper ſurface, *or* equally from all the particles of the Fluid.

Although there be a great affinity between *Cruſts* and *Sediments*, yet they are eaſily diſcerned by this, that the upper ſurface of *Cruſts* is parallel to the lower ſurface, though very rough; but the upper ſurface of *Sediments* is parallel to the Horizon, or elſe very little declining from it. Thus in Rivers the Mineral Cruſts, which ſometimes are green, ſometimes yellow, ſometimes reddiſh, take not away the Unevenneſs of the ſtony bottom; but the Sediment of Gravel or Clay maketh all plain: whence I have been able very eaſily in divers compounded Beds of the Earth to diſtinguiſh Cruſts from Sediments.

About the Matter of *Beds* the particulars following may be determined.

1. If in a Stony Bed all the Particles be of the ſame nature, and withall fine, it cannot rationally be denied, that that Bed was produced at the time of the Creation out of that Fluid which then overwhelmed all: After which manner Monſieur *Des-Cartes* alſo explains the production of the *Beds* of the Earth.

2. If in any Bed there be found the fragments of another Bed, or the parts

of Animals or Plants, 'tis certain, that ſuch Beds are not to be reckoned among thoſe, which in the Creation did ſubſide from the firſt Fluid.

3. If any Bed do give us notice of any Sea-ſalt, of ſpoiles of Sea-animals, of Ship boards, and we ſhall finde the like ſubſtances at the bottom of the Sea; 'tis certain, that one time or other the Sea hath been there, in what manner ſoever, whether by its own overflowing, or by eruptions of Mountains, it got thither.

4. If in ſome Bed or other we find a plenty of Reed, Graſs, Pine--Apples, Branches or Bodies of Trees, or the like, we may ſuſpect, that that matter was carried thither by the overflowing of a River, or the fall of a torrent.

5. If in a Bed there be Coals, Aſhes, Pumice-ſtones, *Bitumen*, and calcined Bodies; 'tis certain, that neer that Fluid there hath been an Eruption of Fire, and that the rather, if the whole Bed be made up of meer Aſhes and Coals: Of which kind I have ſeen one without the City of *Rome*, where they digg out matter for Bricks.

6. If in the ſame place the Matter of

all the Beds be the ſame, 'tis certain, that that Fluid hath not received fluids of a different nature, from divers places at ſeveral times flowing thither.

7. If in the ſame place there be different matter of Beds, then *either* at ſeveral times from divers places there hath been a conflux of different ſorts of Fluids (whether cauſed by various winds, or impetuous falls of rain in certain places,) *or* there hath been in the ſame ſediment, matter of different gravity, whereby the heavier bodies have fallen to the ground firſt, the lighter afterwards: Which variety a viciſſitude of tempeſts may have occaſioned, eſpecially in places where an equal inequality of grounds is ſeen.

8. If amongſt the Beds of the Earth there be found ſome Stony Beds, 'tis certain, *either* that near that place there hath been a ſpring of petrifying Water, *or* that ſometimes there have happen'd Eruptions of ſubterraneous ſteams, *or* that the Fluid, parting from the depos'd ſediment where the upper cruſt was hardned by the heat of the Sun, hath returned again.

Concerning the *Place* of Beds, the following particulars may be reckon'd among Certainties.

1. At the time that any Bed was formed, there was another Body under the ſame Bed, which did hinder the farther deſcent of that duſty matter; and conſequently at the time that the loweſt Bed was formed, there was under it *either* another ſolid Body, *or*, if ſome Fluid was there, *that* was *both* of a different nature from the upper fluid, *and* heavier than the ſolid ſediment of the ſuperiour fluid.

2. At what time there was form'd one of the upper Beds, the lower Bed had then already obtained a Solid conſiſtency.

3. At the time that any Bed was formed, it was *either* at the ſides environ'd by another ſolid Body, *or* it did cover the whole Globe of the Earth. Hence it follows, that, where-ever there are ſeen any naked ſides of Beds, there is *either* to be ſought for a continuation of the ſame Beds, *or* there muſt be found out another

ſolid Body, which kept the matter of the Beds from falling aſunder.

4. At what time there was formed any Bed, the matter incumbent on it was all fluid, and by conſequence, when the loweſt Bed was laid, none of the upper Beds was extant.

Touching the *Figure*,

'Tis certain, that, when any Bed was formed, its inferior ſurface, and that of its ſides, did anſwer to the ſurfaces of the inferior Body and of the Bodies lateral; but the ſuperior ſurface was, as far as was poſſible, parallel to the Horizon: So that all Beds, except the loweſt, were contained in two plains parallel to the Horizon. Hence it follows, that Beds, either *perpendicular* to the Horizon, or inclined to it, have been at another time *parallel* to the ſame.

Nor is it repugnant to what we have ſaid, that the Scituation of the Beds is changed, and that their ſides are bare, as in many places they may now be ſeen; becauſe near thoſe places there are manifeſt tokens of Fires and Waters. For, as Water diſſolving Earthy matter carrieth the ſame down to inclining places, *both* on the ſurface, *and* in the Cavities of the Earth; ſo Fire diſſipating all ſolid Bodies in its way, doth not only expel their lighter particles, but ſometimes alſo caſts out their heavieſt weights; whereby it comes to paſs, that on the Surface of the Earth there are formed Precipices, and Channels; but in the Bowels thereof, ſubterraneous paſſages and Caverns; by the occaſion of which, the *Beds* of the Earth may change their ſcite two ways;

The *Firſt* is, a violent excuſſion of the *Beds* upwards, *whether* that be cauſed by a ſudden accenſion of under-ground Exhalations, *or* by a forcible eliſion of Air occaſioned by other huge neighbouring ruines. This excuſſion of *Beds* is follow'd by a diſperſion of the Earthy matter, and by a breaking aſunder the Stony matter into little ſtones and rubbiſh.

The *other* is, a ſpontaneous falling down of the upper *Beds*, when, the lower matter or foundation being with-drawn, the upper bodies have begun to crack; whence, according to the variety of cavities and crevices there follows a various ſcituation of the broken Beds; for as much as ſome remain parallel to the *Horizon*; others become perpendicular to it; moſt make oblique Angles with it; ſome are bow'd into Arches, being made up of a tough matter: And this Change may happen *either* in all Beds imminent to cavities, *or* in ſome lower ones, the upper Beds being left entire.

This Changed ſcituation of Beds affords an eaſy explication of many things, elſe difficult enough to give an account of.

Hence a cauſe may be given of that Inequality, which on the Surface of the Earth occaſions many controverſies; as *Mountains* and *Valleys*, Receptacles of ſuperiour Waters, Plaineſſes both in high and low places. But, to paſs by the reſt, I ſhall run over a few things concerning *Mountains*.

The Origin of Mountains.

That the changed ſcituation of Beds is the chief *Original* of *Mountains*, is thence apparent, that in the Heaps of Hills there are ſeen,

1. Vaſt Plains on the tops of ſome.

2. Many Beds parallel to the Horizon.

3. On their ſides various Beds variouſly inclined to the *Horizon.*

4. In the oppoſite ſides of Hillocks the faces of broken Beds, ſhewing a perfect reſemblance of matter and ſhape.

5. Bare Rims of Beds.

6. At the foot of the ſame Heap, fragments of broken Beds, *partly* carried together into hillocks, *partly* diſperſed over the neighbouring fields.

7. Moſt evident ſigns of ſubterraneous Fire *either* in the ſtony Mountains themſelves, or in their neighbourhood; even as about the hillocks made up of Earthy Beds are found frequent Waters. And here it is to be noted by the by, that the little Hills, compoſed of Earthy beds, have commonly for their foundation ſome bigger fragments of Stony beds, which in many places keep the incumbent Earthy beds from being diſſolved by the flood of nigh Rivers, and torrents; yea, they often defend whole regions againſt the violence of the Ocean; which the Row or border of Rocks, obtended to *Braſil*, and the every where obvious Rocky ſhores declare.

But Mountains may alſo be produced otherwiſe, as by Eruption of Fires caſting out Aſhes and Stones together with brimſtone and bituminous ſubſtances; as alſo by the impetuouſneſs of Rains and Torrents, whereby the *Stony* beds, being cracked before by the viciſſitudes of heat and cold, are precipitated; but *Earthy* ones, that had been ſplit by exceſſive heats, are diſſolved into many pieces.

Hence it appears, that there are two main kinds of Hills and Hillocks: *one*, of thoſe which are made up of Beds; of which there are again two ſorts, ſome having abundance of Stony, others of Earthy beds; the *other* is of ſuch, which riſe up without any orders out of Fragments of beds and parts broken off. Whence it may eaſily be made out,

1. That all Mountains at this day have not exiſted from the beginning of things.

2. That Vegetation hath no place in Mountains.

3. That the Stones of Mountains have nothing common (beſides ſome ſimilitude of hardneſs) with the bones of Animals;

nimals; ſince they agree amongſt themſelves neither in matter, nor in the manner of production, nor texture, nor uſe; if ſo be, we may pronounce ought of a thing ſo little known as are the *Uſes* of things.

4. That the Ridges or Chains of Mountains ſaid to lye according to certain quarters of the Earth, anſwer neither to Reaſon, nor Experience.

5. That Mountains may be overturn'd and whole Fields transferred; the tops of Hills be raiſed and depreſſed; grounds opened, and cloſed again; and the like things happen, which in the reading of Hiſtories are counted fabulous by thoſe, that will not be taken for credulous.

The paſſages of things flowing out of the earth.

The ſame Change of the ſcituation of Beds affords an out-let to things flowing out of the Earth: ſuch as are,

1. *Waters* ſpringing out of Hills; and in the caverns of Mountains ſever'd from the Air; *whether* they proceed from ſubterraneous Waters, *or*, being by the upper Air condenſed within into one place, are thruſt forth; which latter I believe to be very frequent, in regard that in

moſt caves, diſtilling copious Waters; I have ſeen all, above and below, ſolid.

2. *Winds* breaking out of Hills, *whether* they be Air dilated by heat, *or* that divers ſeveral Fluids, heated by their mutual concourſe, do generate them.

3. Fetid *Exhalations*, and hot or cold *Ebullitions*, &c. Nor is there any doubt left, *that* Cold and Dry places, as often as Water is poured on them, do buble up without any ſign of Heat; *that* at the ſides of a very Cold Fountain there breaks out an Hot Spring; *that* by an Earth-quake an hot Spring may be changed into a cold one, and Rivers alter their courſe; *that* Valleys cloſed round about may caſt the Rain-Waters into lower places; *that* Rivers fallen under ground may elſewhere come forth again; *that* in laying foundations Builders do often labour altogether in vain, meeting with Quick-ſands, as they call them; *that* in ſome places, where Pits are digg'd, are firſt found Waters near the ſurface of the Earth, then, after the Earth hath been digged up to the depth of many feet, new Waters are met with, ſpringing upwards, upon vent given, beyond

the height of the firſt waters; *that* whole Fields with their Trees and Houſes do by degrees ſubſide, or are ſwallow'd unawares, ſo that there come to be vaſt Lakes, where formerly ſtood Towns; *that* thoſe who live on Plains are in *danger* of ſuch ruines, if they be not ſure of a ſtony foundation under them; *that* at times there are open'd Gulfs exhaling a peſtiferous Air, which by ſtore of Bodies thrown in are again ſtopp'd up.

The Origin of variegated Stones, & the Receptacles of Minerals.

The ſame changed Scite of Beds hath occaſioned all ſorts of *Variegated Stones*, and prepared a *Receptacle* for moſt *Minerals*; whether *that* have happen'd in the Fiſſures of Beds, or in thoſe Crevices, which were found in the Matter of them not yet hard, though dry, or between Plates, or in Sciſſures: Or whether in the Interſtices between the upper and lower Beds, after the downfall of the inferiour Beds; or laſtly, whether in Void places left by the reſolution of Bodies there contained. Whence,

1. It may be demonſtrated, that 'tis a very ſlight, and indeed no foundation at

all, on which are built thoſe minute and almoſt ſuperſtitious Diviſions of Veins, uſed by Mine-men; and conſequently that the Divination for ſtore of Mettals to be found, taken from the Roots and Branches of Minerals, is as dubious, as is ridiculous the opinion of ſome of *China* touching the *Head* and *Tayl* of the *Dragon*, which they make uſe of for the finding out in Hills an auſpicious and lucky ſcituation of ſepulchers.

2. That moſt Mines, which Men labour after, have not been extant from the beginning.

3. That in the examination of Stones many things may be diſcover'd, which are in vain attempted in the examination of Minerals; ſince it is more than probable, that all thoſe Minerals, which fill up the cracked or wider ſpaces of Stones, had, for their matter, Vapors driven out of the Stones themſelves, *whether* that have been done before the *Beds* changed their ſcituation (which happen'd, I believe, in the Mountains of *Peru*;) *or* after they had done ſo: And conſequently that in the place of the exhauſted Metal there may grow a new one; which is rather

believed of the Iron-mine in *Elva*, than *known*, becauſe that the Tools of Diggers, and the Idols found there, were ſurrounded not with Iron but Earth.

And theſe particulars I thought not amiſs to examine ſomewhat diligently touching the *Beds* of the Earth, *both* becauſe thoſe *B*eds are Solids naturally incloſed in Solids, *and* that in them are contained almoſt all thoſe *B*odies, which gave occaſion to the Queſtion in hand.

Of Chryſtal.

What concerns the Production of *Chryſtal*, I ſhall not venture to determine the *Manner* of its firſt delineation; but this at leaſt is without controverſy, that what I have met with concerning it in other Writers, is inſignificant: For neither Irradiations (as ſome call it) nor the Figure of the Particles like to the Figure of the whole, nor the perfection of the *Hexagonal* figure, and the tendency of the parts to one and the ſame Center, nor ſuch like other things do anſwer experience; as will appear from ſeveral Propoſitions, which I ſhall lay down, confirmed elſewhere by moſt evident Experiments. *B*ut to avoid confuſion, it will be of uſe, firſt to explain

plain ſome Terms, which in nominating the parts of Chryſtal I do employ.

Chryſtal is compoſed of two Hexagonal *Pyramids*, and an intermediate *Columm* likewiſe hexagonal: Where I call thoſe the *Extreme Solid Angles*, that make up the Tops of the Pyramids; but thoſe the *Intermediate ſolid Angles*, which are made in uniting the Pyramids with the Columne. After the like manner I call the Planes of Pyramids, *Extreme* planes, and the Planes of the Columne, *Intermediate* planes. The Plane of the *Baſis* is a Section perpendicular to all the Intermediate planes. The Plane of the *Axis* is a Section, wherein is the Axe of the Chryſtal, which is compoſed of the *Axes* of the Pyramids, and the Axe of the Columne.

The *Place*, where the firſt concretion of a Chryſtal begins, is doubtful whether it be *between* two Fluids, or between a Fluid and a Solid, or *in* a Fluid it ſelf. But the place, whence a Chryſtal already formed increaſeth, is ſolid on that part where the Chryſtal leans on it, whether it be a Stone, or ſome other Chryſtal before formed; and on the other part 'tis Fluid, if the impediments be remov'd, which may be found from the Unevenneſs of the Stone, or from other afore-produced Chryſtals. Whether the ambient fluid be *Aqueous*, I dare not determine; and it is not cogent, what is alledged of *Water* incloſed in Chryſtals, ſince 'tis certain, that there is Air included as well as Water, and that there are many Chryſtals including Air alone: But then, if Chryſtal were concreted in an *Aqueous* fluid, all ſpaces, every where clos'd up, would be full of Water, ſeeing it hath been conſtantly obſerved, that Water thus ſhut up did never vaniſh.

This *Place* is afforded to Chryſtal by the Hollowneſſes of Stones, variouſly produced. Nor doth it hinder, that whole Hillocks are made up of Earthy matter very full of Chryſtal, becauſe that near the ſame Hillocks are found ſtony Mountains, apt to produce Chryſtals; and even in thoſe very hillocks of Earthy matter there are digged out very big Stones, broken off from the neighbouring Mountains; ſome of which have fiſſures filled up with Marble-matter, juſt as in the ſtony Mountains themſelves the Crevices of Beds are filled up. Now the ſame cauſe, which roleth the fragments of Beds, broken off from the neighbouring Mountains, upon Hillocks, may alſo have diſperſed through the ſame hillocks ſuch Chryſtals as were beaten out of the cavities of the ſame Beds.

As to the Place of Chryſtal, to which is joyned new Chryſtallin matter, the following Propoſitions may ſhew, what is to be ſaid thereof.

I. Chryſtal increaſeth by new Chryſtallin matter being put to the external planes of already delineated Chryſtal: ſo that their opinion can have no place at all, who eſteem, that Chryſtals have a Vegetative growth, and draw nouriſhment on that ſide where they ſtick to their *Matrix*, and that ſo the Particles received by the fluid of the ſtone, and tranſmitted into the fluid of the Chryſtal, are *inwardly* joyned to the Particles of the Chryſtal.

II. *This new Chryſtallin matter is not joyned to all its planes, but for the moſt part to the planes of the top only, or to the extreme planes*; whereby it comes to

paſs,

paſs, 1. That the Intermediate planes, or the quadrilaternal planes are made up of the *baſes* of the extreme planes, and ſo the ſame intermediate planes are bigger in ſome Chryſtals, in other leſſer, in ſome altogether wanting. 2. That the intermediate planes are almoſt always ſtriate or ſtreaked; but the Extreme planes keep the marks of the matter joyned to them.

III. *The Chryſtallin matter is not put to all the Extreme planes at one and the ſame time, nor in the ſame quantity.* Hence it is, 1. That the *Axe* of the Pyramids doth not always make one and the ſame ſtreight line with the Axe of the Columne. 2. That the Extreme planes are ſeldom equal to one another, whence follows an unequality of the intermediate planes. 3. That the Extreme planes are not always triangular, as neither all the intermediate planes are always quadrilateral. 4. That the Extreme ſolid Angle is reſolved into ſeveral ſolid Angles: which alſo often befalls the Intermediate ſolid Angles.

IV. *The Whole plane is not always cover'd with a Chryſtallin matter, but there* *are places left bare, ſometimes toward the Angles, ſometimes toward the ſides, and now and then in the midſt of the plane.* Hence it is,

1. That the ſame Plane, commonly ſo called, hath not all its parts ſcituate in the ſame plane, but in divers, variouſly ſtanding out above it.

2. That the Plane commonly ſo called is in many places not plane, but appears gibbous.

3. That in the intermediate Planes there ariſe inequalities like ſteps of Staires.

V. *Chryſtallin matter joyned to Planes upon the ſame planes, is by the ambient Fluid dilated, and by degrees hardned.* Whence it follows,

1. That the ſurface of Chryſtal becomes the ſmoother, the more ſlowly the matter joyned is harden'd, and that it is left altogether rough, if the ſaid matter be hardned, before it is ſufficiently expanded.

2. That the manner may be diſcerned, how the Chryſtallin matter is joyned to Chryſtal; in regard that, where it hath been concreted ſuddenly, it affords a ſurface

face full of little ſwellings as ſo many puſtuls; juſt as the ſmall drops of an *oily* fluid are wont to float upon an *aqueous* fluid; ſometimes it repreſents alſo trilateral and depreſſed Pyramids, if it have been hardned ſomewhat ſlowly: Winding rings of the falling matter ſhew *both* the place, where the fluid matter did ſettle, *and* that place, toward which is was extended, as *alſo* the order of the matter conjoyned, namely, which came firſt, which laſt. And after this manner there are always found Inequalities in the Chryſtals of Mountains; nor did I ever ſee any Chryſtal, whoſe yet entire ſurfaces have that ſmoothneſs, which the broken ſides of the ſame Chryſtal, broken off, do exhibit: How much ſoever the Writers of Natural things enlarge themſelves in celebrating the ſmoothneſs of Chryſtal cut out of Mountains.

3. That all ſorts of obvious ſolid Bodies are lock'd up in the Chryſtal it ſelf, as if they were limed there by ſome glue, if they have found the ſurface of the Chryſtal not yet conſolidated.

4. That it ſeems to have ſometimes flowed down upon the neighbouring planes.

5. That in thoſe Planes, where ſome places have been left without any Chryſtallin matter conjoyn'd, a new Chryſtallin matter coming and ſpreading it ſelf upon the ſame places, formeth cavities there; at times produceth divers plates, ſometimes includeth part of the external fluid, which is either meer Air, or Water with Air.

VI. *The External Fluid receiveth the Chryſtallin matter from the ſubſtance of the hard Bed:* Whence it comes,

1. That Stones of divers nature, ſweating out divers fluids, produce Chryſtals of different Colours.

2. That in one and the ſame *place*, ſometimes the firſt, ſometimes the laſt Chryſtals become darker, but that in one and the ſame *Chryſtal*, the parts firſt concreted become ſometimes darker than the parts laſt concreted.

3. That when Oyſters, and Cockles, and other Bodies, are waſted under ground, the void ſpaces in them are filled up with Chryſtal.

VII. *The Motion of the Chryſtallin Matter, whereby it is determined towards the plains of the already form'd Chryſtal,* *proceeds not from any common Cauſe of motion in the Ambient fluid, but is varied in every Chryſtal; ſo that it depends indeed from the motion of the ſubtil fluid, which flows out of the already form'd Chryſtal;* Whereby it comes to paſs,

1. That in the ſame place the Chryſtallin matter is joyned to Planes reſpecting the Horizon with a different ſcite.

2. That in one and the ſame Fluid Chryſtals are formed of different Figures.

Whether the ſaid Fluid be that, whereby the Refraction is made, or whether it be a Fluid different therefrom, I leave to the more Ingenious to diſcuſſe. Certainly that there is a great efficacy in a penetrating Fluid, the length of the Threds may evince, which ariſe out of the filings of Iron about the Poles of a Magnet; not only when thoſe filings do cloſely touch the Stone, but alſo thorow interpoſed paper; where, according as the Loadſtone is variouſly moved under the paper, ſo above it, ſuch kind of Threds do *ſometimes* one end of them lying ſtill, at the other end run through all thoſe arches that can be deſcribed within the hemiſphere of the globe, *ſometimes* wholly like ſo many Pike-men make a progreſſive motion from place to place; at *other times*, being bent by the neighbourhood of another Magnet, repreſent an Arch, as if every part of the filings, ſticking to one another, were grown together into one ſolid Body. After the ſame manner I am apt to believe, that by means of the permeating Fluid thoſe drops ſtick together, which when concreted in a *Recipient* by the matter driven out of the Retort, do firſt adhere to the upper part of the Recipient within, but, when ſtore of them have touched one another in the ſame Arch of the Recipient, they thence falling down do forme various globular threds, ſometimes by their extremities ſticking to the ſides of the Recipient, ſometimes intangled in other Threds. Thoſe kind of Threds, which now and then I have obſerved in the Aqueous humour of the Eye I ſhould believe to be made up of globuls in like manner; nor ſhould I think Threds and Branches to be otherwiſe by external appoſition produced in a Fluid. But however it be in theſe, there is in the increaſe of Chryſtal to be conſidered a double motion: *one* which maketh the Chryſtallin matter to be joyned to theſe and not to other places of the Chryſtal; which motion, I gueſs, is to be adſcribed to the *Permeating* ſubtil fluid; to be illuſtrated by the lately alledged Example of the Magnet: The *other*, whereby the new Chryſtallin matter, joyned to the Chryſtal, is ſpread over the Plain, which motion is to be derived from the *Ambient* Fluid. Thus, when the Iron-Threds riſe up upon a Loadſtone, what by the motion of the Air is ſtruck off from one, cometh to the other. To this motion of the Ambient I ſhould attribute, that not only in Chryſtal, but alſo in many other Angular Bodies the oppoſite planes are parallel to one another.

Why in Angular Bodies the oppoſite plains are parallel to one another.

From the things hitherto diſcourſed it might be evinced, that an Extreme Cold is not the efficient cauſe of Chryſtal: *Nor* that it is the Aſhes alone, burnt by the Fire, that are changed into Glaſs: *Nor* the ſole force of the Fire that produceth Glaſs: *Nor* that all Chryſtals were produced in the Beginnings of things but that there are ſtill produced every Day: *Nor* laſtly, that 'tis a thing above the power of Man, to diſcover a production of Glaſs without the violence of Fire, provided he will but ſet upon an accurate Analyſis of ſuch Stones, in whoſe Cavities the beſt Chryſtals are formed. For 'tis certain, that as Chryſtal is concreted in a fluid, ſo the ſame may be reſolved into a fluid, if ſo be you know to imitate the true Diſſolvent of Nature. Nor is it any matter, that ſome Fluid Bodies, when once the reſolving Fluid or their Menſtruum is thence drawn forth, cannot any more be reſolved by the ſame or by the like Reſolvent; for that happens in Bodies, out of which all the Menſtruum is reſolved by the force of Fire; but Chryſtal and all Angular Bodies, which do concrete in the midſt of a reſolvent Fluid or *Menſtruum*, do never become ſo pure, but that ſome Particles of the *Menſtruum* remain betwixt the parts of the Angular Body: whence depends the principal cauſe,* that Chryſtal

How to produce Glaſs without Fire.

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* *The Cauſe of the difference between Chryſtal and Glaſs, in Refraction and other Operations.*

differs from Glaſs both in Refraction and other Operation; for as much as in Glaſs there are not any parts of the diſſolving fluid, being thence driven away by the violence of the Fire: For the fluid, wherein Chryſtal is concreted, is to Chryſtal even as Common Water is to Salts; which might eaſily be proved by an Induction of thoſe things, which the Concretion of Salts hath common with the Concretion of Chryſtal. But leaſt I ſhould too far digreſs from my purpoſe, by enlarging upon all thoſe particulars; I ſhall recite but one Experiment, which ſeemed to me very conſiderable. In one and the ſame Stone, the plates of it, parting in divers places from one another, were full of Chryſtals, of which ſome were aqueous, ſome very ſhining, ſome white, ſome amethyſtine, mixed without any confuſion of colours; juſt in the ſame manner as the Experiments, here made at *Florence* with Salts, do ſhew, that *Vitriol* and *Alom*, being diſſolved in one and the ſame Water, after ſome of the Water is waſted, each of them coagulateth a part, without any mixture of the parts of the other.

Of Angular Bodies of Iron.

The *Angular Bodies* of IRON, as many as hitherto I have met with, may be reduced to three ſorts; of which the *firſt* is plain, and being ſomewhat thick in the middle, by little and little grows thinner towards the extremes, where is ends ſharp all about. The *ſecond* is included in *twelve* plains; and the *third*, in *twenty four*. Out of the ſecond ſort becomes ſometimes an Angular Body made up of ſix plains, reſembling two Trilateral Pyramids, ſo joyn'd by the *baſe* to one another, that the *Angles* of one baſe do biſect the ſides of the other baſe.

The Second and Third ſort of Angular Bodies of Iron do *agree* with Chryſtals;

1. As to the Place of Production; ſeeing that the place where Iron grows, is partly ſolid, partly fluid, and is the hollowneſs of a Stone.

2. As to the place which the matter is joyned unto; for as much as in Iron alſo the matter is joyned not to all, but to ſome certain plains, and to theſe not always all over, not always at the ſame time, but now to one, then to another,

ſometimes towards the extremes, and ſometimes towards the midle.

3. As to the place whence the Iron-matter comes, ſince that alſo ſeems to have iſſued out of the pores of ſome ſolid Body.

4. As to the manner by which the ſame matter by means of the *permeating* fluid, is determined towards the Solid, and by the motion of the *ambient* fluid is extended into a plain, and made ſmooth.

They *differ* as to Matter and Figure. For, Chryſtal-matter is diaphanous, but the matter of Iron is opaque. The Figure of Chryſtal is of Eighteen plains, the twelve extremes of which plains are poliſhed, but the ſix intermediate ſtreaked: But in the Second ſort of Iron there are counted Twelve plains, ſix whereof are the extremes and ſtreaked, the other ſix the intermediate, and poliſhed: And in the Third ſort of Iron there are reckoned Twenty-four plains, the ſix extremes whereof are ſtreaked, the intermediate eighteen poliſhed; ſometimes between the extreme ſtreaked plains there lye ſix other ſhining plains, reſembling the imperfect or cut-ſhort ſides of triangular Pyramids.

I have thought a thing worth conſideration, that by a Cube cut-ſhort may be exactly repreſented the whole number of plains in the *third* ſort of the Angular Bodies of Iron: For *there* are ſix five-ſided plains, which are coincident with the plains of the Cube, and by four angles do biſect each ſide of the plains of the Cube; all the other plains are found in the angles of the Cube, which after a certain manner are cut ſhort.

There is yet another thing in the ſame Angular Bodies of Iron, not leſs to be admired, which is, That in the *Second* ſort of the Angular Iron-bodies the extreme plains, that are ſtreaked and five-ſided, in progreſs of time are changed into three-ſided ones; but the Intermediate plains, which are three-ſided and poliſhed, become five-ſided, having two right-angled Angles cloſe to one another; but betwixt every two five-ſided plains, by which their eight-angled angles touch each other, there are two Triangles or two three-lateral plains likewiſe poliſh'd; ſo that the Second ſort of Iron is changed into the Third ſort.

But now, that after this manner out of a Body of Twelve planes is made a Body of Twenty four planes, I conclude from hence: 1. That in the ſame Aggregat of Iron-bodies, almoſt all the thinner ones have only twelve planes, but the thicker ones, twenty four. 2. That in ſome Bodies of Twelve planes there appear the Beginnings of Triangular planes, which are acceſſory, and being continued make up a Body of Twenty four planes.

In the Triangular planes I have often obſerved ſo perfect a ſmoothneſs, that there appear'd not the leaſt unevenneſs to the eye; which I never yet ſaw in any Chryſtal: In others, I have ſeen leſſer Circular planes put upon greater, the ſuperiour of which were, for the moſt part, cloſe to the *vertex* of the Triangle; ſo that it may be doubted, whether the Five-ſided planes be not made up of the *baſes* of the Triangular planes, conſidering that footſteps of ſtreaks are *there* extant parallel to them.

The manner of the forming of Copper-Ore.

That in *Ore* of *Copper* the Angular Bodies are formed after the ſame manner, as hath been ſaid of Chryſtal and Iron, may be collected from thoſe Copper-pieces, which Your Highneſs keeps amongſt other Curioſities of Nature: But ſeeing that the plenty of the matter fills up all the interſtices of Bodies, 'tis hard to find out the whole Figure of Bodies.

Of Silver-Ore.

Nor is it otherwiſe with the Angular Bodies of *Silver*, tranſmitted to Your Highneſs out of *Germany.*

Of the place and manner of the production of Diamonds.

As to *Diamonds*, and the place and manner of their production; we may from their Fabrick infer the ſame, we did of Chryſtals; namely,

1. That they are produced in a Fluid incloſed in the Cavities of Stones; although a famous Writer of the *Indies* would perſwade us, that Diamonds in a certain number of years do grow again in the Earth, whence they were once digg'd out.

2. That they are produced in a Fluid by the appoſition of Adamantin matter.

3. That in the production of them are to be conſider'd the operations both of the permeating and ambient fluid.

But as to the *Figure*, that is various, ſome being comprifed in eight, others in nine, others in eighteen, and ſome in twenty four planes; in which laſt I have ſeen that moſt planes were ſtreaked, ſome alſo ſmooth: And though ſome of them were angular, yet they had their ſurfaces rather gibbous than plane.

Of the formation of Marcaſites.

The matter of *Marcaſites* puts on various figures: For now it doth incruſtate the ſurface of a plane; at other times it is condenſed into Bodies of many planes; ſometimes it formeth right angled Parallelepipeds, which the vulgar calls *Cubes*; although the equality of all planes be ſeen in few.

Foraſmuch as I have had the opportunity of obſerving many things of the *Cubes* of Marcaſits, both as to the Cubes themſelves, and the Places where they are found, I ſhall only ſpeak of ſuch. Now their production differs from that of Chryſtals.

1. As to the Time; for, the Cubes

of Marcaſites were produced *before* the production of the Beds, wherein they lye; but Chryſtals are coagulated *after* the production of the Beds.

2. As to the Place of production: For, Chryſtal, at leaſt whilſt it was concreting, was incumbent on a Solid Body, and conſequently was contained in a place partly ſolid, partly fluid: But the Cubes of Marcaſites ſeem to have been concreted betwixt two fluids, conſidering that even in the greater Cubes of them there are no marks extant of any cohæſion with another body; though often there be found ſmall Cubes, which in the concreting have come to adhere to one another in the ſurface of the fluid. But now, that ſuch kind of heavy Bodies can remain on the top of a fluid, whilſt one ſurface of them is immediately touched by a ſuperincumbent Fluid of another nature, and lighter, the ſolid demonſtrations of the Great *Galileo* do evince. That of the ſaid fluids one hath been *Aqueous*, the matter of the Bed ſheweth, which hath ſubſided out of the ſame Fluid.

3. As to the Manner and Place of Apposition,

poſition, in regard that the matter of the Marcaſite is joyned to all the plane Cubes, otherwiſe than we have ſaid it falls out in Chryſtals; Which the Uniformity of all ſurfaces manifeſtly ſhews in the Cubes I my ſelf have digg'd out of Stones; all the planes of which had ſtreaks parallel to two ſides, in ſuch a manner that in the oppoſite planes the ſtreaks went in the ſame *ductus* the ſame way, but the planes next to each other had ſtreaks going different ways. From the *ductus* of the ſtreaks it follows, that the Ambient fluid was determined by a three-fold motion about every Cube, whereof one was perpendicular to the Horizon, the other two parallel to it, but perpendicular to each other. Nor will it be difficult to explicate the manner of this three-fold motion: for, whilſt the fluid endeavours to recede from the Center of the Earth, that direct motion is hinder'd by the *baſe* of the Cube; whereby it happens that the ſaid fluid is turned towards the narrower ſides, in regard that the *impetus* of the aſcending fluid through the larger ſides is ſtronger, and therefore permits no paſſage that way; and thus the two pairs of planes are marked with ſtreaks: The third pair of planes receiveth its ſtreaks from that part of the Fluid, which paſſeth between the Cube and the Fluid, reflecting from the *baſe* of the Cube.

4. As to the Perfection of the Figure: For among *Chryſtals* there is very hardly one to be found, in whoſe ſhape there is not ſomething defective, but in the Cubes of the *Marcaſites* there is ſeldom any thing wanting. Nor is it hard to give a reaſon hereof; for ſince that in Chryſtals all the ſolid Angles, (the extreme excepted) are obtuſe, and that to each plane of them the Chryſtallin matter is joyned a part by it ſelf, the ſaid plane becomes ſo much the leſs, whilſt the neighbouring planes alter the figure; But in the Cubes of a Marcaſite, ſeeing that all the ſolid angles are right angles, although new matter be added to one plane alone, that plane ever keeps the ſame magnitude, the neighbouring planes not changing the figure.

Many other things are obſerv'd in the Cubes of Marcaſites; as, Cubes included in Cubes, the Matter of the Marcaſite cover'd with a tranſparent Matter, which incloſeth another Marcaſite, and the like other things, which I reſerve for the *Diſſertation* it ſelf.

There are alſo Angled Bodies, that are reſolved into plates; as Rhomboideal *Selenites's*, which are Rhomboideal Bodies, that are reſolved into other like figured bodies; and ſeveral other Bodies, which though they differ from Chryſtal in many things, yet they all agree with one another in this, that they have been concreted in a Fluid and out of a Fluid: which is likewiſe true of that moſt famous ſubſtance, *Talk*; ſo that thoſe do not at all erre, who believe that the ſolid Body of Talk is diſſolvable into a fluid body, ſeeing it is without controverſy, that it was congeled out of a Fluid, but that thoſe doubtleſs ſhoot quite beſide the mark, that labour to extort this benefit from it by the force of Fire: For, Talk, being accuſtomed to gentler and kinder uſage from Nature, diſdains that cruelty, which the Votaries of Beauty exerciſe upon it, and out of revenge yields to *Vulcan* that part of its own Re-

Talk diſſolvable into a fluid Body.

ſolvent; which till then it kept incloſed in its Body.

If there were made an accurate *Examen* of Angled Bodies, both as to their Compoſition and their Reſolution, we might ſhortly obtain a certain knowledg of the Variety of the Motion, with which the Particles of the Fluid, as well the ſubtil, as the ambient, are agitated: Which part of Natural Philoſophy as it hath been touched by few, ſo it is neceſſary to all for the true explication of Natural operations.

Among Solids naturally included in Solids, there is none that occurs more frequently, and that hath more doubt in it, than the *Cockle-ſhells*: Wherefore I purpoſe to diſcourſe ſomewhat more largely of them, conſidering *firſt* thoſe that are taken out of the Sea; and *then* thoſe, that are digg'd out of Mountains.

Cockle-ſhells largely diſcourſed of.

All ſorts of *Shells*, that once had an animal in them, exhibit to our ſenſes what follows:

1. That the whole Shells are reſolved into little ſhells, but theſe little ſhells

into Threds; which threds are reduced to two ſorts, differing from each other in colour, ſubſtance and place.

2. That in the *little ſhells* the upper and under ſuperfice are nothing elſe but the extremes of the Threds; but the ſuperfice of the *Limbus* or Rim are the ſides of the ſame threds ſcituate in the Rim of the little Shell.

3. That in the Shell it ſelf, the interiour ſuperfice is the ſame with the interiour ſuperfice of the inmoſt or greateſt Shell; but the exterior ſuperfice is compoſed of the exteriour ſuperfice of the leaſt Shell and of the ſuperfice of all the Lims of the intermediat Shells.

Touching the *Manner*, how Shells are produced, the particulars following may be evidently demonſtrated;

1. That the Matter of the Threds is like the ſweat of Animals in this, that it is an humour excreted through the exteriour ſuperfice of the Animal.

2. That the Figure of the Threds may be produced two manner of ways; *either* in the very Pores of the Animal, through which they are excreted; *or* whilſt the ſuperfice of the growing Animal,

mal, being made bigger than the ſuperfice of the long ſince concreted litle ſhell, recedeth from the ſame, and thereby *partly* draws into threds the glutinous humor contained between both ſuperfices (the which is very common to viſcous humors,) *partly* increaſeth it by excreting new moiſture, conſidering that no other matter can penetrate between the ſaid two ſuperfices.

3. That the diverſity of the Threds depends from the difference of the Pores, to be found in the ſuperfice of the Animal, and from the difference of the matter that is excreted by the ſame pores: For ſuch kind of animals have a two-fold ſubſtance in their ſuperfice, whereof one is harder, the other ſofter, both fibrous; the more accurate inveſtigation of which brings no ſmal light to Oſſeology, or the Explication of Bones.

Conſiderable light for the Explication of Bones.

4. That all little Shells, the outermoſt or ſmalleſt excepted, are produced between the exteriour ſhell and the very Body of the Animal, and conſequently have receiv'd their figures not from them-

ſelves, but from the place; whence it comes to paſs, that the motion of the animal and the quantity of the matter do often produce ſome variety of figure in Oyſters. Of the *outer-moſt* little ſhell it may be doubted, whether the Ambient fluid have *touched* the exteriour ſuperfice, or whether it have been *cover'd* by a membrane. For my part, I am apt to believe, that the latter only can be true: 1 Becauſe that the threds of all the other little ſhells at the time of their concretion were not touch't by the Ambient fluid. 2. Becauſe that in the hairy round Shel-fiſhes (called by the Latins *Chamæ*) we ſee, that ſomething like a membrane or leather doth outwardly cover the Shells. But the queſtion is about an almoſt unſenſible thing; and it may be ſaid, that the threds of the firſt little ſhell were then hardned when they were yet within the Egge; it being certain by experience, that Oyſters and other teſtaceous animals are bred of Eggs, and not of putrid matter.

Teſtaceous Animals bred of Eggs, not putrid matter.

From what hath been ſaid, may eaſily be explained, 1. All that variety of

Colors and Pricks, which are wondred at by many both in our own and in outlandiſh ſhels; ſeeing it proceeds from nothing elſe, than from the *limb* or rim of the animal included in the ſhell. For this lim, whilſt from a ſmall one it is by little and little growing and dilating it ſelf, it leaveth in each rim of the little ſhels its image; foraſmuch as the ſaid rims are *either* concreted out of the moiſture, which ſweats out of the lim of the animal; or are the lims themſelves of the creature, which, as the Teeth in Sea-Dogs, do perhaps grow up a new in the place of the former rim, and, in the manner of the ſame teeth, are by little and little thruſt outward.

The manner of the production of Pearls, both more and leſs round ones.

2. The Production of *Pearls*, both of thoſe, which adhering to the ſhels, are not ſo very round, and of thoſe, which, when the orifices of the pores are obſtructed in the ſuperfice of the Animal, acquire a round figure within the pores themſelves: For between the *coats* of the Pearls, and the *ſhells* of the Pearl-bearing Cockles there is only this difference, that the threds of the ſhels are as

'twere ſcituate in the ſame plane; but the coats of the Pearls have their threds diſpoſed all over the ſame ſpherical superfice. A very fine inſtance whereof was afforded us by one among thoſe, that were at the command of Your *Highneſs* broken by me, which being white without, did include within, a black body like a grain of Pepper both as to colour and ſize; in which was moſt evident the ſcituation of the threds, by one extreme reſpecting the center; wherein alſo the orders and ſpheres of the ſame threds could be diſcerned. On the ſame occaſion I ſaw, 1. That Pearls, which are unequal by many little knobs, are nothing elſe than many little Pearls incloſed by the ſame common cruſt. 2. That many yellowiſh Pearls are tinged thus yellow not only in the outward ſuperfice of the ſphere, but alſo in all their interiour ſpheres; ſo that it needs not to be doubted any longer, that that colour is to be adſcribed to the changed humors of the animal, and that he waſheth the Blackamore, that taketh pains to waſh it out, unleſs the colour be

What poſſibility there is of making yellow Pearls white, and of imitating Pearls.

adventitious,by wearing the Pearl about the Neck, or only ſuch in the outermoſt yellow ſphere, the humors of the Animals not yet being changed at the time when the internal ſpheres were formed. Whence their error is manifeſt, who without conſulting Nature will imitate the forming of Pearls by their phancy; whereas hardly any one hath attempted it with ſucceſs, except he have, like another *Lucullus*, replenisht Ponds with Pearl-bearing ſhels, or have ſearched in the animals themſelves for the ways of multiplying them, or thence learn'd the difficulty of imitating Nature's Works. I will not deny, that there may be made litle globuls by art,compoſed of various tunicles or coats; but to diſpoſe the coats out of a row of threds joyn'd to one another, whence that native brightneſs of Pearls depends, that is the thing, which I judge moſt difficult to effect.

Shells under ground.

The *Shells* that lye under ground, may be reduced to three ſorts.

The *Firſt* is of thoſe, that are ſo like to thoſe lately deſcribed, as an Egg is to an Egg; foraſmuch as the *Shells* themſelves are reſolved into *litle Shells*, and the little Shells into Threds, and there is the ſame difference in the Threds, as alſo the ſame poſition or ſcite. That theſe Shells were once the parts of Animals living in a Fluid, though there never had been ſeen any Teſtaceous Marine Greatures, the very view of the Shell it ſelf evinceth, as may be evident by the Inſtance of *Bi-valve Cockle-ſhells.*

At the time that the Bi-valve Cockle-ſhells were formed, the matter, contained within them,

1. Had a ſmooth ſurface, having innumerable pores, and two different ſorts of pores.

2. It had a flexile ſubſtance, and leſs hard than the Shell it ſelf.

3. It communicated with the ambient matter on one ſide, but had no commerce with it on the other.

4. It did by little and little recede from that ſide, where the communication with the external matter was denied it, towards that ſide, where it had that commerce with the ſame matter free.

5. It hath been able by intervals to open it ſelf according to the wideneſs of

the angle, which the hinges of the Shels admit.

6. Of ſmall it is become great.

7. It hath tranſmitted the matter, whence the little Shells are made, thorough its own ſubſtance.

The *External Matter* environing the Cockle-ſhels, 1. If it was not altogether fluid, at leaſt it had leſs force to reſiſt, than the matter contain'd within the Cockles had of expanding it ſelf. 2. It contained a fluid matter fit to make of it threds of little ſhels: All which conditions both of the internal and external place, being in the *Diſſertation* it ſelf demonſtrated by arguments and figures, do ſufficiently evince, that there was an animal within the Cockles; and a Fluid without the Cockles.

The *Second* ſort is of thoſe Shells, which in the reſt are like to the lately deſcribed ones, but differ from them only in colour and weight; in regard that ſome of them are found too light, others too heavy, foraſmuch as *theſe* have pores fill'd up with an adventitious juyce, but the pores of *thoſe* are widen'd by the expulſion of the lighter parts: Which I

ſhall

ſhall ſay no more of, they being nothing elſe but either petrify'd or calcin'd Shels of animals.

The *Third* ſort is of ſuch as in their figure alone reſemble thoſe, that were newly diſcours'd of, but for the reſt totally differ from them, ſeeing that in them are to be found neither the little Shels, nor the Threds, much leſs the diverſity of the Threds. Of theſe ſome are *Aereal*; ſome *Lapideous*, of either a black or yellow colour; others *Marbly*, others *Chryſtallin*; others of other matter; the production of all which I explain in manner following.

Where the penetrating force of juyces hath diſſolved the ſubſtance of the Shell, the ſame juices being either drunk up by the Earth have left the ſpaces of ſhels void (which I call *Aereal* Shels,) or being alter'd by new adventitious matter, have, according to the variety of that matter, fill'd up the ſame ſpaces of ſhels either with Chryſtal, or Marble, or Stone: Whence comes that very pretty kind of Marble called *Nephiri*, which is nothing elſe but a ſediment of the Sea full of all ſorts of Shells, where the ſubſtance of the Shels being waſted, a ſtony ſubſtance is come into the place thereof.

My deſign of being ſhort here, will not allow me to make a Deſcription of all thoſe particulars, which I have found obſervable in every ſort of Shels digg'd out of the Earth; wherefore, leaving other things, I ſhall only relate here what follows;

1. That there was found a Pearl-bearing ſhell in *Toſcany*, a Pearl yet ſticking to the Shell.

2. A piece of the greater Sea-nacre, (*pinna marina*,) in which, the ſilk like ſubſtance within the Shell being conſumed, the colour of that ſubſtance did remain in that Earthy matter, which had fill'd the Shell.

3. Likewiſe ſome Shels of Oyſters of a ſtrange bigneſs, wherein are found many oblong cavities ſuppos'd to be eaten out by Worms, altogether like thoſe, which in the *Anconitan*, *Neapolitan* and *Sicilian* Stone are inhabited by a kind of Snail; which hollowneſſes of Stones if they be not made out of dirt by ſome Inſects making their neſts, (which I ſcarce believe, ſeeing that the very ſubſtance of

the midle part of the Stone, where no cavities are found, is the ſame with the ſubſtance of the cavities, which are all about the ſuperfices,) they are certainly eaten out by Worms; as both appears by the ſuperfice of the cavity, and is evinced by a certain body found in many cavities, woven together out of pretty thick filaments, which Body in ſize and ſhape anſwers to the cavity it ſelf. Certainly they are not made by the Snails, nor about the Snails, ſeeing that ſuch teſtaceous fiſhes have no organs fit to gnaw, nor doth any cavity anſwer to the figure of the ſhells. Nor is it a wonder, that Stones expoſed to the Sea ſhould in the ſaid cavities harbour Shell-fiſhes Eggs thrown out by the Sea, ſince I have hitherto ſeen none of them that was deſtitute of a manifeſt out-let. If any one ſhall ſay, that thoſe cavities were produced by a lapideſcent juyce concreted about certain bodies, I anſwer, that then there would have been found ſome cavities every where overlaid with the ſame matter *without* an out-let.

4. More-over, a Shell in part waſted inwardly, where a marbly cruſt, cover'd

with many *balanus*'s, did ſupply the loſs of the conſum'd ſubſtance: ſo that we may certainly conclude, that this Shell was by the Sea left upon the Land, and was carried back into the Sea, and again cover'd with a new ſediment, and then left by the Sea again.

5. Alſo ſome very ſmall Eggs, and Turbinated Shells hardly viſible but by a Microſcope.

6. Likewiſe ſome Scollops, *Turbo's*, and Bi-valve Cockles, not cover'd with Chryſtal, but Chryſtallin in their whole ſubſtance.

7. Various tubulous Shells of Sea-worms.

Other parts of Animals found under ground.

What hath been ſaid of *Shells*, the ſame is to be ſaid of other parts of Animals, and of the Animals themſelvs buried under ground: of which number are the *Teeth* of *Sea-Doggs*, the Teeth of the *Fiſh Aquila*, Fiſhes *Back-bones*, all ſorts of *whole Fiſhes*, *Skulls*, *Horns*, *Teeth*, *Thigh-bones*, and other bones of Terreſtrial Animals; conſidering that all theſe either quite reſemble the true parts of

Teeth of Sea-Dogs, Fiſhes, Skuls, Horns, Bones, &c.

of animals, or only differ from them in weight and colour, or have nothing common with them but the outward figure only.

There occurs a great difficulty in that vaſt number of *Teeth*, which every Year are brought out of *Maltha*; ſeeing that almoſt no Ship goes thither, but it brings back ſome of them. For my part, I can find no other anſwer to that difficulty but this: 1. That ſuch Sea-Dogs have, each of them, ſixty teeth, and more; and that all the time they live they breed new teeth. 2. That the Sea agitated by the Winds is wont to protrude thoſe bodies, it meets with, towards ſome one place, and there heap them together. 3. That Sea-Dogs go by Flocks, and conſequently that the Teeth of many Dogs may have been left in one place. 4. That in the Lumps of *Maltha*-Earth, brought hither, beſides the ſeveral Teeth of divers Dogs, there are alſo found ſundry Cockle-ſhels; ſo that, if the *Number* of the Teeth ſhould incline a Man to aſcribe their production to the Earth, on the other hand the *Make* of the ſame teeth, and the abundance of them in every animal, and the Earth like the bottom of the Sea, and other Marine Bodies found in the ſame place, do favour the contrary opinion.

Bigneſs of Thigh bones, Skuls, &c. found under ground.

Others find a difficulty in the bigneſs of the *Thigh bones, Skuls, Teeth*, and other Bones, digg'd out of the Earth. But neither is this Objection ſo conſiderable, as that the unuſual bigneſs ſhould make us conclude it to be a ſize beyond the power of Nature: For, 1. In our Age there have been ſeen Men with very long faces. 2. 'Tis certain, that there were once Men of a monſtrous bigneſs. 3. Often thoſe are believed to be Humane Bones, that are Bones of other Animals. 4. 'Tis the ſame thing, to aſcribe to Nature the production of Bones truly fibrous, and to ſay, that Nature can produce the Hand of a Man without the reſt of the Man.

Some there are, to whom it ſeems, that the length of time overthrows the force of all the other Arguments; conſidering that 'tis recorded by no Age, that Inundations have gone up ſo far as thoſe places, where now many Marine Bodies are found, excepting the Univerſal Deluge; from the time of which there are reckon'd about 4000 Years to theſe our days: Nor doth it ſeem conſonant to reaſon, that the part of an Animal Body ſhould ſo long reſiſt the injuries of ſo many Years, ſince we ſee, that often within the ſpace of a few Years the ſame Bodies are deſtroy'd totally. But this Objection may eaſily be anſwer'd, by ſaying, that that whole buſineſs depends from the diverſity of the Soil: For, I have ſeen Beds of a *Clayie* kind, which by the thinneſs and fineneſs of its juyce did reſolve all Bodies inclos'd in it; but I have obſerved *Sandy* Beds, which preſerved all Bodies lodged therein; by which experiment we may be led to the knowledg of that juice, which reſolveth ſolid Bodies. But that 'tis certain, that the production of many Shells, we meet with in our days, is to be referr'd to the times coincident with the General Deluge, the following argument evinceth.

Shells found in our Days as old as the univerſal Deluge.

'Tis certain, that before the foundation of the City of *Rome*, the Town of *Volaterra* was then already powerful; but in thoſe huge Stones, which in ſome places are found there (being the remainders of very ancient Walls,) there are found all ſorts of Shells ; and not long ſince, in the midle of the Market-place, there was cut out a Stone full of ſtreaked Cockles ; ſo that 'tis indubitable, that the Cockles, now found in the ſaid ſtones, were already produced at that time when the *Volaterran* walls were rais'd. And leaſt it ſhould be ſaid, that the Shells alone, being turn'd into ſtone, or included in ſtone, had ſuffer'd no damage by the waſtful time ; 'tis to be noted, that the whole Hillock, on which the moſt ancient Town of the *Etrurians* is built, riſeth out of the ſediments of the Sea, laid on one another, and parallel to the Horizon ; where many Beds not ſtony do abound with true Cockles that have ſuffer'd no change at all : So that we may confidently ſay, that thoſe Cockles, which at this day we have drawn from thence, and that are unchanged, have been produced Three Thouſand Years ago, and more. From the building of the City of *Rome* until theſe times we reckon about 2420. Years : And who will not grant that many Ages elapſed from the time that the firſt People ſeated themſelves there, until 'the place grew to that bigneſs, and power, it had at the time when *Rome* was built? To which Ages, if we ſhall add that time, which paſſed from laying the firſt ſediment of the *Volaterran* Hillock, to the time when the ſame was relinquiſh't by the Sea, and the Aliens there ſetled, we ſhall eaſily come up to the very times of the Univerſal Deluge.

The ſame authority of Hiſtory will not let us doubt, that thoſe vaſt Bones, which are digg'd up out of the *Aretine* Fields, have laſted 1900. Years; it being certain, 1. That the Skuls of labouring Beaſts, found there, are not of Animals of this Climat, as neither are thoſe huge Thigh-bones, and long Shoulder-blades, met with in the ſame place. 2. That *Annibal* paſs'd there, before he gave Battel to the *Romans* at the Lake of *Thraſimene*. 3. That in his Army there were *African* Beaſts, and huge Turret-bearing Elephants. 4. That, when he came down the *Feſulan* Hills, there periſh'd by the Waters in the Mariſhes the greateſt part of the loden Animals. 5. That the place, whence the ſaid Bones are digg'd, was heaped up by various Beds, that are full of Stones thither devolved from the circumjacent Mountains by the impetuouſneſs of Torrents. So that every one, that ſhall but compare the condition of the place, and the Kind of the Bones with the Hiſtory, will find all things evidently agree together.

Of Plants under ground, or inclos'd in ſtony ſubſtances.

What is ſaid of Animals and their parts, ſuteth likewiſe with *Plants* and the parts of Plants, whether they be digg'd out of Earthen Beds, or lodged within ſtony ſubſtances. For *either* they do altogether reſemble true Plants and their parts (which are rarely found,) *or* they differ from them only in colour and weight, (which do occur more frequently, either burnt into Cole, or impregnated with a petrifick juyce;) *or* they only anſwer them in figure, of which there is great abundance in many places.

Of the two firſt ſorts it is not to be doubted that once they were true Plants; the texture of the Bodies themſelves evincing it, and the condition of the place, where they are digg'd, not diſagreeing thereto. Thoſe that object, that Earth tranſported into Houſes in proceſs of time is changed into Wood, can only affirm *that* of the Earth's ſuperfice, including the Wood, where the Earth, dried in time and crumbled into duſt, diſcover'd the Wood incloſed therein: Neither do they urge, that in the pores of the ſame Wood there have been found Metallick threds; whereas I my ſelf have pull'd out of the Earth a ſtem; which by the Knots of the boughs, and by the Bark appear'd to be a Plant, whoſe crevaces were fill'd with a Mineral matter.

Light to the Doctrine of Minerals.

From hence alſo might no ſmall light accrue to the Doctrin of Minerals, if inquiry were made in *Wood*, and in the *place* of Wood, what they may contribute to the production of Minerals. Many things paſs under the name of *Bitumen*, of which yet it may be evinced by the *ductus's* of fibres, and the aſhes of them when burnt, that they are nothing but Coles.

The *third* ſort hath more difficulty in it, I mean the *Figures* of Plants impreſs'd by nature upon Stones; foraſmuch as we obſerve ſuch kind of Figures in Hoar-froſt, the Mercurial Tree, ſeveral Volatil

Salts, and a white ſubſtance reſoluble into Water, which in Glaſs-veſſels not only comes to ſtick on the ſides within, but ſometimes from the midle of the bottom riſeth up into the Air.

But all being well conſider'd, there is nothing in all this, that's contrary to the deliver'd opinions. To ſhew which, we may take notice, that the Figures of Plants to be found upon Stones are reducible to two ſorts; *ſome* are ſeen only in the ſuperfice of the crevaces, which I will eaſily allow were produced without any true Plant, though not without a Fluid; *others* do not only appear in the ſuperfice of the rifts, but ſpread their litle ramifications every where thorough the very lapideous ſubſtance it ſelf,; whence it follows, that, at the time when the ſaid Plant was produced, whether that were done after the way of other Plants, or after that of a Mercurial Plant, the very ſubſtance of the Stone had not then yet ceaſed to be a Fluid: Which is further confirm'd not only by the very, ſomewhat yet left, conſiſtence of the Stone, but alſo by the Angular Bodies that are frequent in the *Dendroitis* of

Elva, which do never concrete but in a free fluid. But what need of other Arguments, when Experience it ſelf ſpeaketh? I have viſited and view'd divers *ouſy* places, both above and under ground, where ſtones, growing by the præterfluent Water unto Moſſe and other Plants, were cover'd with new Moſſe of ſeveral kinds.

Hitherto I have diſcourſed of the chief Bodies, whoſe *place*, where they are found, hath made many doubt of the place of their production; and on that occaſion I have withall intimated, how from that which is ſenſible, ſomething certain may be concluded about that which is not ſenſible.

Various changes that have happen'd in Tuſcany.

But now, How the *Preſent* ſtate of a thing may diſcover the *Former* ſtate of the ſame, will particularly appear by the Example of *Etruria* or *Toſcany*; in the preſent face whereof thoſe obvious inequalities afford manifeſt arguments of the ſeveral Changes that have happen'd therein: Which I ſhall here reckon up by an inverted order, and a retrogradation from the laſt to the firſt.

1. Sometime the inclined Plane **A** hath been in the ſame Plane with the higher Horizontal Plane B, and the rim of the ſame Plane A thus raiſed, as alſo the rim of the higher Horizontal Plane C, have been further continued, whether the lower Horizontal Plane D have been in the ſame Plane with the higher Horizontal Planes B, C, or whether there have been another ſolid Body propping up the naked ſides of the higher Planes; or, which is all one, in the place where at this day are ſeen Rivers, Lakes, depreſſed plainneſſes; Precipices, and inclined Planes between ſandy Hillocks, all thoſe were anciently Planes, and at that time the Waters, both of Rains and Springs, did either cover that ſame Plane, or open'd to themſelves ſubterraneous Channels under the Plane; at leaſt there were cavities under the ſuperiour Beds.

2. At the time when the Plane B, A, C, and the other Planes under it were formed, the whole Plane B, A, C, was cover'd with Water; or, which is all one, the Sea hath once been raiſed above the Sandy Hills, or Downs, how high ſoever.

3. Before the Plane B, A, C, was for-

med,

med, the Planes F, G, had the ſame ſcite; they obtain now; or, which is all one, before the Beds of the Sandy Hillocks were form'd, there were in the ſame places deep Vallies.

4. Once the Inclin'd Plane I. was in the ſame Plane with the Horizontal planes F, and G, and the naked ſides I, and G, were either continued farther, or *there* was exiſtent another ſolid, propping up the ſame naked ſides, when the ſaid Planes were form'd; or, which is all one, where at preſent, Vallies are ſeen between the plane tops of higheſt Mountains, there was once a continued Plane, under which were made vaſt cavities, before the ruines of the ſuperior Beds.

5. When the Plane F, G, was form'd, the Aqueous fluid was incumbent on it; or, which is all one, once the plane tops of the higheſt Mountains were cover'd with Waters.

Hence it is, that we may diſtinguiſh *Six* diſtinct caſts of the Country of *Etruria*, and that it hath been twice Fluid, twice Plane and Dry, and twice ſcabrous and Craggy. Which as I make it out to be true of *Etruria*, from many places attentively view'd by me; ſo I confirm it to be true of the *whole Earth*, from the Deſcriptions of many places deliver'd by divers Authors. But leaſt there ſhould be apprehended any danger in the novelty, I ſhall in ſhort lay down the agreement of *Nature* with *Scripture*, reciting withall the chief difficulties, that may be raiſed about each Face of the Earth.

As to the *firſt* Face, *Scripture* and *Nature* agree in this, that all was cover'd with Water; but how it began to be thus, and when, and how long 'tis continued ſo, Nature is ſilent, Sripture is not. But that that Fluid was Aqueous, at the time when there were yet no Animals nor Plants, and that it cover'd all, the *Beds* of the higher Hills, containing no hete-ogeneous bodies at all, do evince; whoſe *Figure* ſpeaks that there was a Fluid, and he *Matter*, that there were no heteroge-eous Bodies; but the *likeneſs* of the Matter and Figure in the Beds of divers nd diſtant Mountains ſhew, that Fluid to ave been Univerſal.

If any one ſhall ſay, that the hetero-eneous Solids contain'd in thoſe Beds ave been in length of time conſum'd, it cannot be deny'd, that there would have been a conſpicuous difference obſervable between the Matter of the Bed, and the Matter percolated through the pores of the Bed, and filling the ſpaces of the waſted Bodies. But if upon the Beds of the firſt Fluid there ſhould in ſome places other Beds be found ſtuffed up with different Bodies, thence would follow nothing elſe than that upon the Beds of the firſt Fluid there were depoſed new Beds from another Fluid, the matter of which new Beds might have filled the ruines of the Beds that were left by the firſt Fluid: ſo that we muſt always recurr to this, that at the time when thoſe Beds of ſimple matter, and which are obvious in all Mountains, were form'd, the other Beds were not yet extant, but all were cover'd by a fluid, deſtitute of Plants, Animals and other Solids: which Beds being of that kind, which none can deny but that they may have been immediatly produced by the Firſt Mover, we do acknowledg a manifeſt conſent between Scripture and Nature.

Of the *Second* Face of the Earth, which was Plain and Dry, Nature is likewiſe ſilent,

lent, when and how it began, but the Scripture is not ſo: Mean time, that there was once ſuch a Face of the Earth, Nature affirms, and Scripture confirms, for as much as it teacheth, that Waters ariſing from one Spring did water the whole Earth.

Of the *Third* Face of the Earth, which was Craggy, neither Scripture nor Nature determines, *when* it began. Nature indeed ſhews, that that Inequality was great; and the Scripture maketh mention of Mountains at the time of the Deluge; but at *what time* thoſe Mountains, which the Scripture there ſpeaketh of, were produced; whether they were the ſame Mountains with thoſe of this time; whether in the beginning of the Deluge there was the ſame depth of Valleys that now is, or whether, for depreſſing the ſuperfice of the much growing Waters the new breaches of Beds did open new gulfs, neither Scripture nor Nature decideth.

The *Fourth* Face, when all was Sea, ſeems to have more difficulty in it; although indeed it be all eaſy. That the Sea hath been higher, than now it is, the production of the Hillocks out of the ſediment of the Sea ſheweth; and that not only in *Etruria*. but in very many places remote enough from the Sea, whence the Waters fall towards the Midland Sea; yea in thoſe places alſo, whence the waters flow into the Ocean. How great that height of the Sea hath been, where Scripture determins it, Nature contradicts it not; foraſmuch as, 1. There are certain marks of the Sea extant in places, which are many hundred feet high above the ſurface of the Sea. 2. It cannot be denied, that, as all the Solids of the Earth were in the beginning of things cover'd with an aqueous Fluid, ſo they may have been cover'd with it again, in regard that the change of natural things is indeed continual, but there is no Natural Annihilation. But who hath ſearch'd into the ſtructure of the Bowels of the Earth, ſo as to dare to deny that there may be vaſt ſpaces, now filled with an Aqueous, at an other time with an Aereal Fluid? 3. Let it be uncertain, what was the depth of the Valleys in the beginning of the Deluge; but let reaſon perſwade, that in the firſt Ages of the

World there were eaten out leſſer cavities by the Water and Fire, and conſequently that thereupon follow'd leſs deep ruines of Beds: But the higheſt Mountains, mention'd in Scripture, were the higheſt of thoſe Mountains, that were to be found at that time, but not of thoſe at this day. 4. If the motion of an Animal can effect, that, according to pleaſure, places that are now overwhelm'd with Water, ſhall be rendred dry, and by and by drown'd again by new waters; why ſhould we not be ready to grant to the Firſt Mover of all things the like liberty and the like power? About the Time of the *Univerſal* Deluge, Civil Hiſtory is not repugnant to Sacred, reciting all things concerning it particularly. The ancient Towns of *Etruria* extend their Foundation to above Three Thouſand Years; of which Towns ſome are built on Hillocks produced by the Sea: But in *Lydia* we approach nearer to Four Thouſand Years; whence it may be inferr'd, that the time, when the Earth was relinquiſh't by the Sea, is conforme to the time, which the Scripture mentions.

What concerns the Manner of the *growing* Water, we may alledg many ways ſutable to the Laws of Nature. If it ſhall be ſaid, that in the Earth the Center of *Gravity* is not always the ſame with the Center of the *Figure*, but that now and then it recedes from one or the other ſide, according as the ſubterraneous cavities are grown in divers places; 'tis eaſy to render a reaſon, why the Fluid, which in the beginning of things covered all, left certain places dry, and return'd to them again. With the ſame eaſe may be explain'd the *General Deluge*, if we place about the Fire in the midle of the Earth a Sphere of waters, or at leaſt certain Receptacles of them; whence, without the motion of the Center, the powring forth of the included Water may be deduced. But the following way ſeems alſo very eaſy to me, whereby both a leſſer depth of Vallies, and a ſufficient quantity of Water is found, without reſpect had to the Center either of the Figure, or of the Gravity. For, if we ſhall admit, 1. That by the fallen fragments of ſome Beds the paſſages

An eaſy Explication of the General Deluge.

ges were obſtructed, by which the *Sea*, penetrating into the hollowneſſes of the Earth, ſends the Water to the heads of Springs; 2. That the Water, which is undoubtedly included in the bowels of the Earth, was, by the force of the acknowledged ſubterraneal fires, partly driven towards the Springs, partly thruſt forth, through the pores of the not yet drown'd Earth, into the Air; but that that Water, which *both* is ever inherent in the Air, *and* was commix't with it in manner aforeſaid, was fallen down in Rain; 3. That the Bottom of the Sea was rais'd up by the dilated caverns under the Earth; 4. That the remaining cavities in the ſurface of the Earth were fill'd up with earthy matter, worn off from higher places by the continual afflux and waſhing away of Rains; 5. That the very ſurface of the Earth was leſs unequal, as nearer to its beginning: If, I ſay, we ſhall grant theſe particulars, we ſhall grant nothing contrary to reaſon nor daily experience. What did happen in the ſurface of the Earth whilſt it was cover'd with Water, neither Scripture nor Nature declareth; this only we may affirm from Nature, that deep Vallies were then produced: 1. Becauſe that the Cavities being by the force of Subterraneous Fires made more ſpacious, gave place to greater ruines. 2. Becauſe that a return was to be open'd for the Waters into the deeper parts of the Earth. 3. Becauſe that at this Day in places remote from the Sea are found deep Vallies fill'd with many marine Sediments.

In the *Fifth* Face, which, the Earth being made dry again, did ſhew vaſt Plaineſſes, Nature demonſtrateth, that thoſe Plaineſſes did exiſt, and the Scripture contradicteth it not. Mean time, whether the whole Sea did preſently recede; or whether in ſeveral ages new Gulfs being open'd gave occaſion to diſcover new Countries, ſince Scripture is ſilent hereof, and the Hiſtory of Nations about the firſt Ages from the Deluge is doubtful to the Nations themſelves, and hath been believed full of Fables, we may not determine any thing certain thereof. Yet this is certain, that a great parcel of the Earth is every year carried into the Sea (as is obvious to him, that ſhall conſider the largeneſs of Rivers, and the long paſſages through the Midland Countries, and the innumerable number of Torrents; in a word, all the declivities of the Earth) and conſequently that the Earth carried away by the Rivers and joyned to the Sea-ſhores does every day leave new Lands fit for new Inhabitants: Which is confirm'd by the Opinion of the Antients, which ſaith, that whole Regions were the guifts of Rivers of the ſame name; as alſo by the Tradition of the *Greeks*, importing, that Men coming down from the Hills by litle and litle, ſetled themſelves in the Maritim places, barren by reaſon of their too much moiſture, but in time made fruitful.

The *Sixth* Face of the Earth is obvious, whereby the ſaid Plaineſſes were chiefly by the eroſion of Waters, ſometimes alſo by the exuſtion of Fire, changed into various Channels, Vallies and Precipices. Nor is it to be wonder'd, that Hiſtorians have not recorded it, at what time every ſuch change hath happen'd; for, the Hiſtory of the firſt Ages after the Floud is confuſed and dubious amongſt Profane Authors; and in after-Ages they undertook to write and celebrate the Actions of renown'd Men, and not the wonders of Nature. Mean time we want the Records, quoted by Authors, of thoſe that have written the Hiſtory of Changes fallen out in divers places; and ſince other Writers, whoſe Monuments have been preſerv'd, do ſpeak of and reckon among Prodigies, Earthquakes, Eruptions of Fires, Inundations of Rivers and Seas, as happen'd almoſt every year; 'tis evident, that in 4000 Years there have happen'd many and various Mutations. So that thoſe do much miſtake, who affirm, that in the writings of the Antients there are many errors, becauſe (forſooth) there occur many things in them diſſonant from the modern Geography. I would not give credit to theſe relations, which are fabulous in Antient Writers; but there are many things to be met with in them, which alſo I would not disbelieve. For, of that kind I there find divers things, whoſe falſity rather, than verity ſeems dubious to me; ſuch as are, *That the Mediterranean Sea was ſever'd from the Weſtern Ocean; That*

there

Not all what is diſſonant in the old Geography from the modern, preſently falſe.

there was a paſſage out of the Mediterranean into the Red Sea; the ſubmerſion of the Atlantid Iſland; And the Deſcription of many places in the Expeditions of *Bacchus*, *Triptolomus*, *Ulyſſes*, *Æneas*, and others, may be true, though it agree not with things as they are at this Day. In the *Diſſertation* it ſelf I ſhall employ evident demonſtrations to evince moſt of the Changes, that have happen'd in *Etruria* in all that Tract, which lyeth between the Rivers *Arno* and *Tiber*; and though the time, in which every one came to paſs, cannot be aſſigned, yet I ſhall bring ſuch Arguments out of the Hiſtory of *Italy*, that no ground of doubt ſhall be left behind.

And this is a ſuccinct, not to ſay a tumultuary relation of the chief things, which in the *Diſſertation* it ſelf I intended to explain both more diſtinctly and more largely, together with a Deſcription of the places, where I had obſerv'd every particular.

Explication of the Figures.

WHereas the brevity of an haſty Writing hath made me deliver ſome things leſs clearly, eſpecially where I ſpeak of *Angular Bodies* and the *Beds of the Earth*; I have, for ſome more clearneſs, annexed here a few Figures choſen out of many.

The *thirteen* firſt figures, deſigned to explain the *Angular* Bodies of Chryſtal, are reducible to two *Claſſes*.

The *firſt* contains *ſeven* differences of a Plane, in which is the *Axis* of the Chryſtal. In the 1*t*. 2*d*. and 3*d*, the *axes* of the parts, out of which the body of the Chryſtal is compoſed, do conſtitute one ſtraight line, but by an intermediate column, which in the 1*ſt* figure is wanting, but is ſeen ſhorter in the 2*d*, and longer in the 3*d*. In the 4*th* figure the *axes* of the parts conſtituting the body of the Chryſtal, do not make one ſtraight line. The 5*th* and 6*th* figure are of the kind of thoſe, of which I could have produced innumerable, to evince, that in the Plane of the *axe*, both the number and length of the ſides are variouſly changed without change in the angles, and that in the very midſt of the Chryſtal there are left various cavities, & formed various plates. The 7*th* figure doth ſhew in the plane of the *axe*, how from the new Chryſtallin matter laid upon the planes of the pyramids, both the number and length of the ſides are variouſly ſometimes increaſed, ſometimes leſſen'd.

The *ſecond* Claſſis contains *ſix* differences of the *Baſis* of a Plane. In the 8*th* 9*th*, 10*th*, and 11*th* figures, there are only ſix ſides; yet with this difference, that in the 8*th* figure all the ſides are equal; in the 9*th* and 11*th*, not all but only the oppoſite ſides are equal; but in the 10*th*, all oppoſit ſides are unequal. In the 12*th* figure, the Plane of the *baſe*, which ſhould be hexagonal, contains twelve ſides. The 13*th* figure ſhews, how, by laying a new Chryſtallin matter upon the planes of the Pyramids, ſomtimes the length of the ſides, and the number alſo are variouſly changed in the plane of the baſe, without changing the angles.

The *ſix* following figures do explain two divers kinds of Angular bodies of *Iron*. The 14*th*, 15*th* and 16*th* figures ſerve to explain thoſe Angular bodies of Iron, that have *twelve* planes; & of them the 14*th* figure repreſents all thoſe 12 planes laid out in one plane, ſix of which are triangular and poliſh't; the other ſix, pentagonal and ſtreaked. The 15*th* figure is the plane of the *baſe* of the ſame body. The 16*th* figure is the plane of the *axis* of the ſame body.

The 17*th*, 18*th* and 19*th* figure ſerve to explain thoſe Angular bodies of Iron, that have *thirty* planes; and of them the 17*th* figure exhibits all thoſe 30 planes, explicated in one plane; *ſix* of which are pentagonal and poliſh't; *twelve* are triangular, poliſh't likewiſe; *ſix* are triangular and ſtreaked; and ſix are quadrilateral oblong and poliſh't. The 18*th* figure is the plane of the *baſe* of the ſame body. The 19*th* is the plane of the *axe* of the ſame body.

The *ſix* laſt figures do *both* ſhew, how from the preſent face of *Etruria* we may collect the ſix diſtinct faces of the ſame Country, above diſcourſed of, *and* ſerve alſo for the more eaſy underſtanding of the particulars, we have deliver'd concerning the *Beds* of the Earth. The *pricked* lines repreſent the *Sandy* beds of the Earth, ſo nominated from their *main* matter, there being mix't with them divers both Clayie and ſtony beds. The other lines repreſent the *Stony* beds, likewiſe ſo called a *potiori*, ſeeing there are Beds found in them that are of a ſofter ſubſtance. In the *Diſſertation* it ſelf I have explain'd the Letters of the figures, in that order wherein the figures follow one another: Here I ſhall only reckon up in ſhort the order of the change.

The 25*th* figure exhibits the perpendicular Plane of *Etruria*, at the time when the Stony Beds were yet entire, & parallel to the horizon.

The 24*th* ſhews the vaſt cavities, eaten out by the force of Fire and Water, without any breach in the upper Beds.

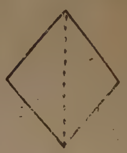
The 23*th* repreſents, how Mountains & Vally's came to be made by the ruine of the ſuperior Beds.

The 22*th*, that by the Sea new Beds were made in the ſaid Valleys.

The 21*th*, that of the new Beds the lower ones were conſumed, the uppermoſt remaining untouch't.

The 20*th*, that by the breach of the ſuperior ſandy Beds *there* were produced Hillocks and Vallys.

FINIS.



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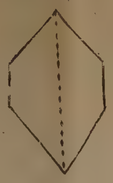

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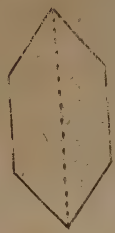

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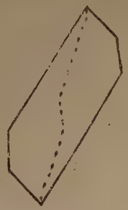

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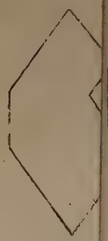

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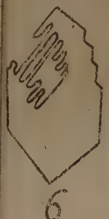

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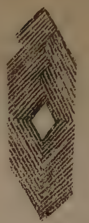

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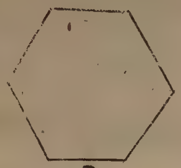

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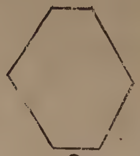

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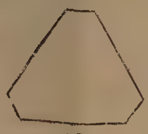

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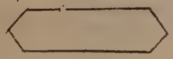

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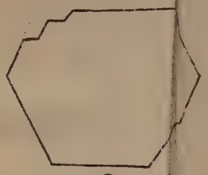

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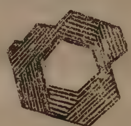

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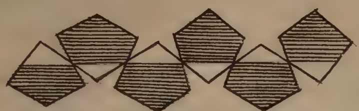

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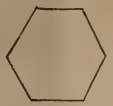

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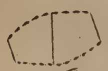

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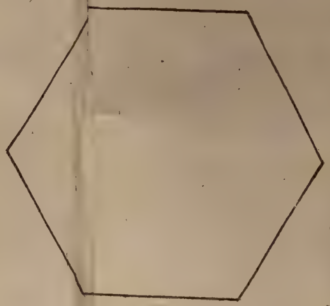

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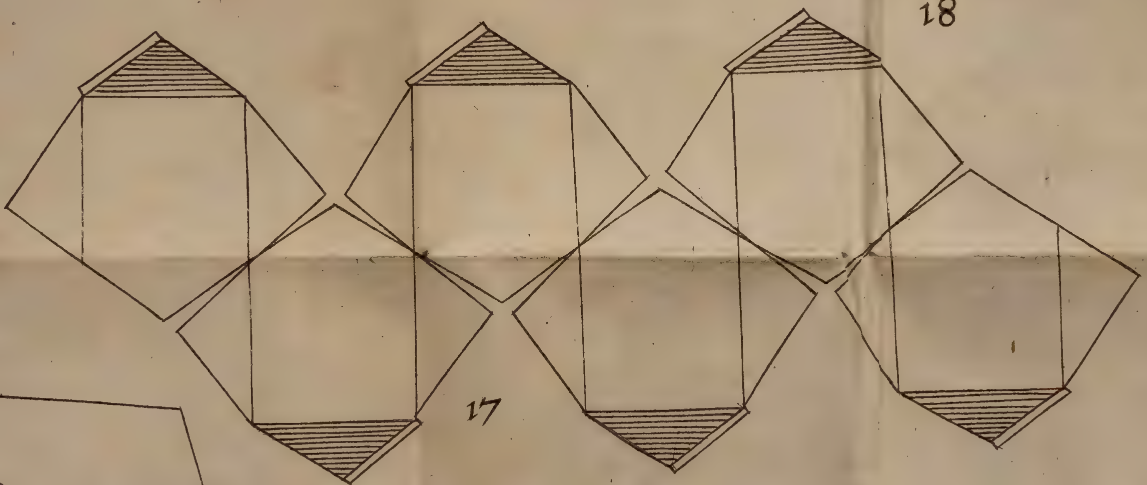

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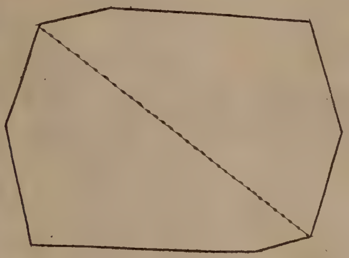

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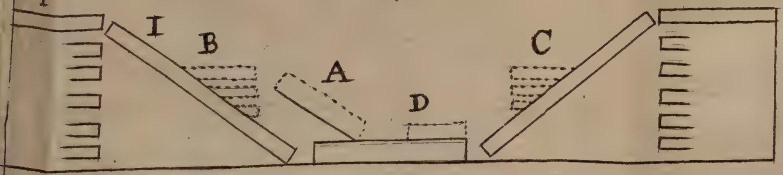

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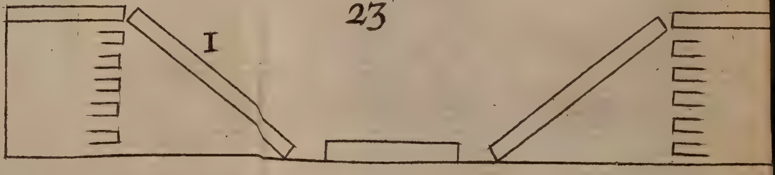

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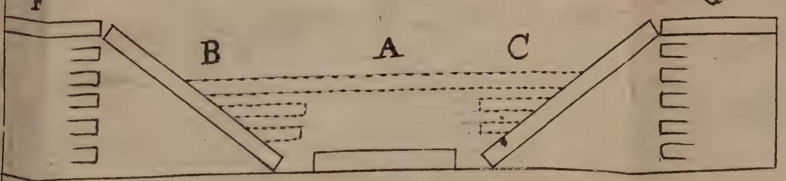

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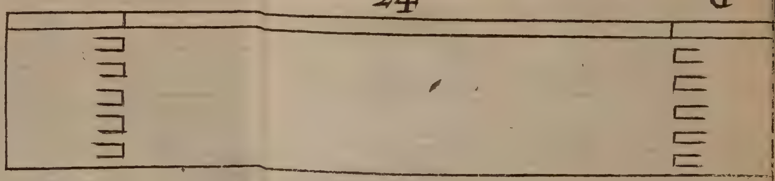

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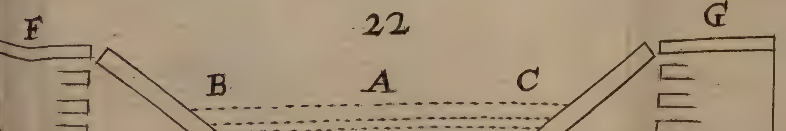

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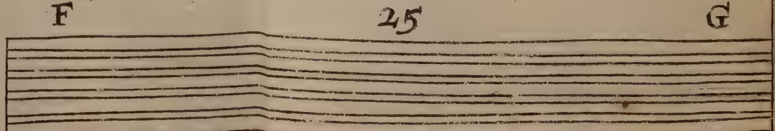

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